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FIFTY-THIRD ANNUAL REPORT

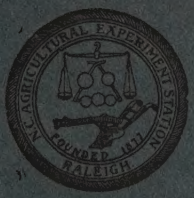
OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

R. Y. WINTERS, DIRECTOR

THE NORTH CAROLINA STATE COLLEGE
OF AGRICULTURE AND ENGINEERING
AND
STATE DEPARTMENT OF AGRICULTURE
COOPERATING

STATE COLLEGE STATION
RALEIGH



FOR THE FISCAL YEAR ENDING, JUNE 30, 1930
PROGRESS REPORT FOR YEAR ENDING,
DECEMBER 1, 1930

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DECEMBER 1, 1930

LETTER OF SUBMITTAL

STATE COLLEGE STATION,
RALEIGH, N. C.

PRESIDENT E. C. BROOKS,
North Carolina State College of Agriculture and Engineering,
State College Station, Raleigh, N. C.

DEAR SIR:

I have the honor to submit herewith the annual report of progress in agricultural research of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering and the North Carolina State Department of Agriculture. The report contains recommendations for strengthening research and a summary of results accomplished at the Central and Branch stations during the fiscal year ending June 30, 1930.

Respectfully yours,

R. Y. WINTERS, *Director.*

LETTER OF TRANSMITTAL

RALEIGH, N. C.

HONORABLE O. MAX GARDNER,
Raleigh, North Carolina.

MY DEAR GOVERNOR:

I take pleasure in transmitting to you the Fifty-third Annual Report of the North Carolina Agricultural Experiment Station. The report records the accomplishments of agricultural research for the year ending June 30, 1930.

The work of the past year has been conducted in accordance with the program approved by the Experiment Station Committee.

Very sincerely yours,

E. C. BROOKS, *President.*

EXPERIMENT STATION COMMITTEE

(Appointed by Board of Trustees of College)

D. J. Lybrook, Advance, N. C.
Harry V. Latham, Belhaven, N. C.
*W. D. Laroque, Kinston, N. C.
J. S. Watkins, Virgilina, Va.
W. A. Bullock, Red Springs, N. C.
Dr. L. J. Herring, Wilson, N. C.
David M. Buck, Bald Mountain, N. C.

(Appointed by State Board of Agriculture)

S. C. Lattimore, Shelby, N. C.
W. A. Brown, Rocky Mount, N. C.
E. G. Roberson, Leicester, N. C.
F. P. Latham, Belhaven, N. C.

*Deceased.

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OFFICERS AND STAFF

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

JANUARY 1, 1930

E. C. BROOKS ..... *President of the College*
I. O. SCHAUB ..... *Dean of the School of Agriculture*
R. Y. WINTERS ..... *Director*
C. B. WILLIAMS ..... *Vice-Director*
*F. E. MILLER ..... *Director of Branch Stations*
F. H. JETER ..... *Agricultural Editor*
A. F. BOWEN ..... *Treasurer*

AGRONOMY

C. B. WILLIAMS ..... *Agronomist*
L. G. WILLIS ..... *Soil Chemist*
J. R. PILAND ..... *Assistant Chemist*
H. B. MANN ..... *Associate in Soil Fertility Investigations*
A. S. CLINE ..... *Soil Fertility Investigations*
W. A. DAVIS ..... *Assistant in Soil Survey*
E. F. GOLDSTON ..... *Assistant in Soil Survey*
R. B. DEVEREAUX ..... *Soil Survey, in Coöperation with U. S. Department of Agriculture*
R. C. JOURNEY ..... *Soil Survey, in Coöperation with U. S. Department of Agriculture*
F. O. BARTEL ..... *Senior Drainage Engineer, in Coöperation with U. S. Department of Agriculture*
P. H. KIME ..... *Associate in Plant Breeding*
G. M. GARREN ..... *Assistant in Plant Breeding*
J. H. MOORE ..... *Cotton Technologist*
E. G. MOSS ..... *In charge Tobacco Investigations for the State Department of Agriculture and U. S. Department of Agriculture*
R. Y. WINTERS ..... *Plant Breeder*

ANIMAL INDUSTRY

R. H. RUFFNER ..... *Head, Animal Industry*
C. D. GRINNELLS ..... *Dairy Investigator*
J. E. FOSTER ..... *Beef Cattle and Sheep Investigations*
E. H. HOSTETLER ..... *Beef Cattle, Sheep and Swine Investigations*
J. O. HALVERSON ..... *In charge Animal Nutrition*
F. W. SHERWOOD ..... *Associate in Animal Nutrition*
F. H. SMITH ..... *Assistant in Animal Nutrition*

AGRICULTURAL ECONOMICS

G. W. FORSTER ..... *Economist*
J. G. KNAPP ..... *Agricultural Economist*
R. H. ROGERS ..... *Associate Agricultural Economist*
W. B. GOODING ..... *Farm Management*

Botany

B. W. Wells.....*Botanist*
S. G. Lehman.....*Plant Pathologist*
R. F. Poole.....*Plant Pathologist*

Horticulture

J. H. Beaumont.....*Horticulturist*
M. E. Gardner.....*Associate Horticulturist*
Robert Schmidt.....*Associate Horticulturist*
C. F. Williams.....*Associate Horticulturist*

Poultry Husbandry

B. F. Kaupp.....*Poultry Investigator and Pathologist*
R. S. Dearstyne.....*Associate Poultry Investigator and Pathologist*
W. G. Crowder.....*Poultryman*

Rural Sociology

C. C. Taylor.....*Sociologist*
W. A. Anderson.....*Sociologist*

Zoology and Entomology

Z. P. Metcalf.....*Entomologist*
B. B. Fulton.....*Associate Entomologist*

Central Station

F. E. Miller.....*Director of Branch Stations*
R. J. Harris.....*Foreman*

*Branch Stations

Blackland Test Farm

J. L. Rea, Jr.....*Assistant Director in Charge*

Coastal Plain Test Farm

Chas. Dearing.....*Assistant Director in Charge*

Mountain Test Farm

S. C. Clapp.....*Assistant Director in Charge*

Piedmont Test Farm

†F. T. Meacham.....*Assistant Director in Charge*

Tobacco Test Farm

E. G. Moss.....*Assistant Director in Charge*

Upper Coastal Plain Test Farm

R. E. Currin, Jr.....*Assistant Director in Charge*

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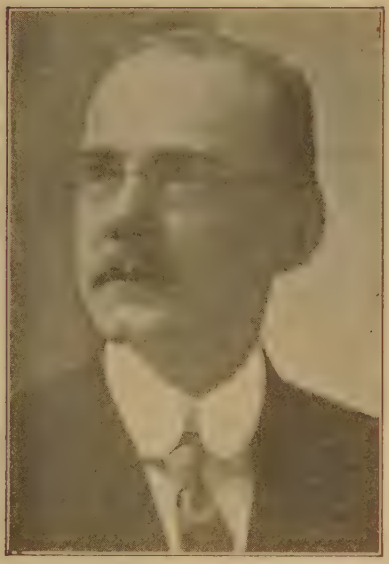
* Workers and Branch Stations under authority of the State Department of Agriculture co-operating with the Agricultural Experiment Station in research.
† Deceased.



DR. HERBERT BEMERTON BATTLE
Director 1887-1897

Dr. H. B. Battle, third Director of the North Carolina Experiment Station, died on July 3, 1929, at his home in Montgomery, Alabama.

Dr. Battle served as Director of the Station from September 1, 1887, to July 1, 1897. During this period the scope of research work was enlarged by the addition of the Departments of Agriculture, Botany and Entomology, Horticulture, Poultry, Veterinary Science, and Meteorology, as well as by a substantial increase in personnel in the Department of Chemistry. This latter department, with a small experimental farm, comprised the entire Station when Dr. Battle assumed his duties as Director. He received both his Bachelor of Science and Doctor of Philosophy degrees from the University of North Carolina, after which, in 1882, he began a service of six years as assistant chemist to the Experiment Station. In 1887 he was elevated to the directorship.

Dr. Battle relinquished the duties of Director in 1897 and entered commercial work. He organized and directed as president the Southern Chemical Company of Winston, N. C., during the year of 1897 to 1901. Later he was associated with the Southern Cotton Oil Company for a period. In 1906 he established the Battle Laboratories at Montgomery, Alabama, and was president of this concern until the time of his death.

Dr. Battle was a man of excellent qualities and wide experience. He was a devout member of the Episcopal Church, and was always interested in

and spent some of his best efforts in promoting the public welfare. He was the author of a number of books on chemical subjects and was a frequent contributor to chemical journals. His death is regarded as a great loss to the science of chemistry in the South, and the workers of the North Carolina Experiment Station feel that a true man and a splendid worker has passed to his reward.

In Memory of Dr. Edwin West Allen

On November 11, 1929, agricultural research in the United States lost by death an eminent leader in the person of Edwin West Allen, Chief of the Office of Experiment Stations of the United States Department of Agriculture. The North Carolina Experiment Station has been the beneficiary of his wise policies, his thoughtful council, and his friendly interest.

RESEARCH PROJECTS

FARM ANIMALS

Beef Cattle

1. Beef cattle management studies in Eastern North Carolina.—Cooperation Bureau of Animal Industry.
2. Comparison of carbonaceous roughage for beef cattle. Piedmont Branch Station.
3. The quality of meat of native versus grade Hereford calves. Blackland Branch Station.
4. Comparison of tame grasses and native reed pastures for beef cattle.—Blackland Branch Station.
5. Vitamin A studies with special reference to cottonseed meal feedings with young beef animals.—Central Station.

Dairy Cattle

6. Study of dairy cattle as a supplementary enterprise to cotton farming in the Piedmont section of North Carolina.
7. Study of dairy cattle as a supplementary enterprise to cotton farming in the Piedmont section of North Carolina.
8. Comparison of different sources of concentrates for dairy cattle with the purpose of utilizing homegrown feeds.
9. Calf feeding studies.
10. Comparison of silo wall preparations for the protection of tile and metal silos.
11. Pasture fertilization with special reference to its returns of milk, animal maintenance and sod.
12. A study of the effects of heavy grazing upon the maintenance of pasture sod and its effect upon pasture yields.
13. Bovine infectious abortion. Methods of eradication and control.

Sheep

14. The value of a pure bred ram in the upgrading of native Eastern Carolina sheep.
15. Control of stomach worms in sheep by drenching.
16. The efficiency of sanitary measures as means of controlling stomach worms in sheep.
17. Comparison of returns from crops utilized in temporary pasture for sheep.
18. Cost of raising lambs to marketable age.
19. A study of methods of wintering the farm flock.

Swine

20. The cost and returns from two brood sows, one boar and their offspring.
21. A study of the relation of the Vitamin A content of the Wenona ration to lameness of swine at the Blackland Branch Station.

22. The value of mineral supplements for swine.
23. The use of cottonseed meal in the ration for fattening swine and for the maintenance of brood sows.
24. The utilization of peanut gleanings for swine.
25. Relation of quantity of salt and time of curing to quality of pork.
26. Value of pastures for fattening pigs. (a) To determine if pigs grazed on permanent pasture will consume less concentrates than those in a dry lot when both are fed the same grain mixture. (b) To determine if permanent pasture will replace 50 per cent of the nitrogenous feed in the grain ration.
27. Soft Pork Studies. To determine the hardening of varying the percentage of cottonseed meal in the hardening ration.
28. Utilization of sweet potato gleanings by swine in the commercial sweet potato producing area of the northeastern section of the State.

ANIMAL NUTRITION

29. Study of the components of Vitamin B complex in cottonseed meal, soybean meal and linseed meal.

POULTRY

30. Experimental fattening poultry and capon production.
31. Study of commercial plant management under North Carolina conditions.
32. Cost of putting pullets into lay.
33. Influence of cod liver oil on production and growth of poultry.
34. The cost of broiler production with the battery brooder.
35. Influence of meat meal versus milk upon production and health of poultry.
36. Study of commercial plant management under North Carolina conditions.
37. Pathological Hematology of the fowl.
38. Investigations of septicaemic diseases among fowls in North Carolina: Studies of soil pollution with fowl typhoid under natural conditions: The tolerance of the domestic fowl to single vaccination with varying quantities of avin typhoid vaccine.
39. Study of the intermittent reactor to the agglutination test for Pullorum disease (Bacillary White Diarrhea). 1. Continuation of study of fluctuations in serum titer of reactors on bi-monthly test. 2. Study of the "Negative phase" of the agglutination. 3. Soil pollution studies.
40. A study of contagious diseases of chicks.

FARM CROPS

COTTON

41. A study of the efficiency of certain concentrated fertilizers for the production of cotton on seven of the principal soil types of the Coastal Plain region.

42. A comparison of complete fertilizers of the same nutritive ratio and quality of plant food, but differing in concentration, when measured by stand and yield of cotton on Norfolk fine sandy loam. (Upper Coastal Plain Branch Station.)
43. The influence of varying the rates and methods of applying concentrated complete fertilizers upon the stand and yield and quality of sweet potatoes grown on Norfolk loamy fine sand. (Outlying field Currituck County.)
44. Comparative efficiency of fertilizer of the same nutritive ratio but differing in concentration and source of materials for cotton on Cecil clay loam. (Outlying fields Catawba County.)
45. A study of methods of applying concentrated fertilizers to cotton on Cecil sandy loam soil. (Central Station.)
46. Comparative efficiency of fertilizers the same nutritive ratio but differing in concentration and source of materials for cotton—
    (a) When applied as single and fractional applications.
    (b) When supplemented by rarer elements, such as magnesia, sulphur, copper, etc.
47. On Norfolk sandy loam soil of Wayne County, and Cecil clay loam soils of Catawba County.
48. A study of methods of applying fertilizer to cotton with special reference to their influence upon stand, quality and yield on Norfolk sandy loam. (Upper Coastal Plain Branch Station.)
49. A study of cotton varieties and strains with special reference to new types that may be introduced into the cotton production program of the State.
50. Cotton breeding with special reference to meeting the needs of manufacturers of the State.
51. Study of the inheritance and association of economic qualities in cotton.
52. Cotton culture studies with special reference to the time of preparing the seed bed for cotton.
53. Study of the value of different spacings in the row for cotton on Norfolk sandy soil.
54. A study of the relation of certain physical properties of cotton fibers to spinning and cotton improvement.
55. Control of seed borne infections.
56. Fertilizer requirements for cotton grown on Georgeville clay loam and Appling sandy loam. (Outlying field Orange and Davie counties.)
57. A study of the relation of phosphoric acid, nitrogen and potash ratio to early maturity and yield of cotton under boll weevil conditions. (Upper Coastal Plain Branch Station.)
58. A study of the effects of varying the phosphorus ratio in a complete fertilizer upon the yield and maturity of cotton when the nitrogen and potash ratios are kept constant. (Outlying fields of Piedmont and Coastal Plain areas.)
59. Efficiency of sources of nitrogen when compared in a complete fertilizer (10-4-4) and measured by the yield and quality of cotton produced. (Upper Coastal Plain Branch Station.)

60. Comparison of sulphate of ammonia and nitrate of soda when used separately and when used together to supply equal quantities of ammonia in an 8-6-4 fertilizer for cotton. (Upper Coastal Plain Branch Station.)
61. A study of plant responses to some ammonia-calcium ratios in fertilizers. (Central Station, Upper Coastal Plain Branch Station, and outlying fields.)
62. A study of the effects of rate and time of applying muriate of potash upon the yield and quality of cotton and corn on Norfolk sandy loam, Portsmouth sandy loam, Cecil sandy loam, and Iredell loam soils. (Piedmont and Coastal Plain.)
63. A comparison of the efficiency of sources of nitrogen when each are used as the sole source of nitrogen and in certain combinations of a complete fertilizer for cotton on Cecil sandy loam. (Central Station.)
64. A comparison of the efficiency of ten sources of nitrogen when each are used as the sole source of nitrogen in a complete fertilizer for cotton and corn. (Piedmont Branch Station.)
65. A study of the effects of varying the ratio of inorganic to organic sources of nitrogen in a complete fertilizer upon the yield and quality of cotton on Cecil clay loam, Cecil sandy loam, and other soils. (Central Station and outlying field.)
66. A study of plant responses to some ammonia-calcium ratios in fertilizers. (Central Station, Upper Coastal Plain Branch Station, and outlying fields.)
67. A study of the effects of rate and time of applying muriate of potash upon the yield and quality of cotton and corn on Norfolk sandy loam, Portsmouth sandy loam, Cecil sandy loam, and Iredell loam soils. (Piedmont and Coastal Plain.)

CORN

68. A study of methods of inter-cropping corn with soybeans, and its influence upon the yield of corn and soybeans in current and succeeding crops. (Coastal Plain and Mountain Branch Stations.)
69. A test of different methods of harvesting corn and its influence upon yield and quality of grain. (Central Station.)
70. Fertilizer requirements for corn grown on Ashe loam, Ashe silty clay loam, and Cecil clay loam soils. (Outlying fields Burke, Avery and Buncombe counties.)
71. Fertilizer requirements for corn and wheat grown on Toxaway loam. (Outlying field Transylvania County.)
72. A study of sources and rates of application of different forms of lime for corn on peat soil when used with and without a complete fertilizer. (Blackland Branch Station.)
73. Corn variety and strain studies for improving seed corn for North Carolina conditions. (Mountain and Coastal Plain Branch Stations, Central Station, and five outlying fields.)

FORAGE CROPS

74. Soybean diseases.
75. Fertilizer, lime and manganese, and other nutritional requirements for soybeans grown on Coxville silt loam. (Outlying field Pasquotank and Currituck counties.)
76. Soybean breeding for increased yield and other desirable qualities.
77. Soybean variety experiments.
78. A study of the comparative value of American grown and imported varieties and strains of alfalfa.
79. A study of the coöperative value and adaptability of American grown and imported red clover seed.
80. Comparison of spring seeding and fall seeding of red clover.
81. Lespedeza variety, fertilization, culture and utilization studies. Cooperation Bureau of Plant Industry, U. S. Department of Agriculture.
82. Comparison of grains, grain mixtures, grain and legume mixtures, as sources of forage and grazing crops. (Blackland Branch Station.)

PEANUTS

83. Fertilizer requirements of peanuts and cotton grown in rotation on Norfolk sandy loam soil. (Upper Coastal Plain Branch Station.)
84. A study of factors influencing the size, quality, growth and yield of Virginia peanuts.
85. A study of the influence of certain dusts and sprays upon the growth and yield of peanuts on Norfolk sandy loam soil.
86. A study of the effects of time and method of applying gypsum and ground limestone upon the yield and quality of peanuts. (Outlying field, Bertie County.)

SMALL GRAIN

87. Small grain varieties and strains for Mountain, Piedmont and Coastal Plain regions.
88. Studies of wheat varieties and strains in relation to their resistance to leaf and stem rust.
89. Study of the influence of different rates and dates of seeding oats upon the yield and quality of grain on Norfolk sandy loam. (Upper Coastal Plain Branch Station.)
90. Wheat, oat, barley and rye seed improvement studies in relation to the requirements of different areas of the State. (Mountain, Piedmont and Coastal Plain regions.)
91. Wheat rust control studies.

TOBACCO

92. Variety and strain tests of tobacco with special reference to quality, yield and resistance to disease. (Tobacco and Coastal Plain Branch Stations.)
93. A study of the effects of different sources of potash upon the yield and quality of tobacco when used with and without dolomite and calcite

on Durham sandy loam. (Tobacco Branch Station, and Coastal Plain Branch Station.)

94. A study of the effects of different sources of nitrogen upon the quality and yield of tobacco when applied alone and as a sole source of nitrogen in a complete fertilizer on Durham sandy loam soil. (Tobacco and Coastal Plain Branch Stations.)
95. A study of the effects of magnesia upon the quality and yield of tobacco when applied in varying amounts to plats that receive a complete fertilizer on Durham sandy loam soil. (Tobacco Branch Station.)
96. A study of the effects of magnesia, sulphur, and chlorine upon the quality of tobacco when applied with a complete fertilizer composed of ammonium nitrate, di-calcium phosphate and potassium nitrate on Durham sandy loam. (Tobacco Branch Station.)
97. A comparison of sulphate and muriate of potash as sources of potash in a complete fertilizer for tobacco when used with and without applications of dolomite on Durham sandy loam. (Tobacco Branch Station.)
98. A study of the fertilizer requirements for tobacco when grown in a three-year rotation with oats, cowpeas and rye on Durham sandy loam. (Tobacco Branch Station.)
99. A study of the effects upon yield and quality of tobacco when grown with different combinations of cotton, corn, small grain, legumes, meadow and fallow to form three year rotations on Durham sandy loam. (Tobacco Branch Station.)
100. A study of the effects upon yield and quality of tobacco when grown in a four-year rotation with crimson clover, corn, oats, cowpeas (for hay) and Sudan grass on Durham sandy loam. (Tobacco Branch Station.)
101. To what extent can phosphoric acid and potash be used to correct the effects upon quality of tobacco when cowpeas are turned under on a two-year rotation of oats, cowpeas and tobacco, on Durham sandy loam. (Tobacco Branch Station.)
102. A study of the efficiency of sanitary measures for the control of tobacco mosaic.
103. A study of soil and plant treatments for the control of tobacco wilt, black shank and root rot.

JAPANESE MINT

104. Fertilizer and lime requirements for Japanese mint on Wilkes sandy loam (smooth phase). (Vick Chemical Company.)

CROP ROTATIONS

105. Fertilizer and lime requirements for cotton, rye, corn, wheat and red clover when grown in rotation on Cecil clay loam. (Piedmont Branch Station.)
106. Fertilizer and lime requirements for corn and soybeans grown in rotation, the soybeans being utilized for seed production in one series, and for hay production in another. (Upper Coastal Plain, and Blackland Branch Stations, in Okenee sandy loam and peat.)

107. Fertilizer and lime requirements for crops in a three-year rotation of corn, oats, vetch, soybeans (turned under), rye (turned under), soybeans (for seed) and rye (turned under) on Norfolk fine sandy loam soil. (Coastal Plain Branch Station.)
108. Fertilizer requirements for crops in a three-year rotation of corn, oats, soybeans broadcast (turned under) and Irish potatoes on peat soil. (Blackland Branch Station.)
109. A study of the yields and quality of succeeding crops when corn and cotton are grown continuously and when grown in combinations with each other and with legumes in two and three-year rotations. (Upper Coastal Branch Plain.)
110. A study of yields and quality succeeding crops when cotton, corn and peanuts are grown continuously and when they are combined in two, three and four-year rotations. (Upper Coastal Plain Branch Station.)
111. Studies of the efficiency of superphosphate, rock phosphate and basic slag as sources of phosphoric acid.
112. Comparison of rock phosphate and superphosphate for corn and crimson clover (turned under) in a one-year rotation on Toxaway loam.
113. Rock phosphate and superphosphate compared as sources of phosphoric acid for corn, oats, wheat and soybeans grown in rotation.
    (a) When supplemented with normal amounts of nitrogen and potash.
    (b) When supplemented with stable manure.
    (c) When supplemented with potash and legumes turned under.
114. Rock phosphate, superphosphate and Duplex Basic Slag compared as sources of phosphoric acid for corn, wheat and red clover in rotation.
    (a) The sources of phosphoric acid are supplemented with normal amounts of nitrogen and potash.
    (b) The superphosphate and basic slag applied in normal amounts and the rock phosphate applied in one, two, four, six and eight times the normal amounts.
115. Studies of the efficiency of superphosphate, rock phosphate and basic slag as sources of phosphoric acid.
    1. Comparison of rock phosphate and superphosphate when applied to corn, wheat and red clover grown in rotation on Cecil clay loam. The superphosphate applied in normal, two, three, four, six and eight times the normal amounts.
116. A study of the utilization of crops grown in rotation with cotton by two different methods. (Upper Coastal Plain Branch Station.)
117. Fertilizer requirement for corn, wheat and soybeans when grown in a two-year rotation on Toxaway loam soil. (Mountain Branch Station.)
118. A study of the yields and quality of succeeding crops when corn and wheat are grown continuously and when grown in two and three year rotations with and without legumes on Porters loam. (Mountain Branch Station.)
119. A study of the yields and quality of succeeding crops when wheat and corn are grown continuously and when grown in two and three year rotations with small grain and legumes on Cecil clay loam soil. (Piedmont Branch Station.)

120. A comparison of limestone, burnt lime and hydrated lime when used with acid phosphate for crimson clover, soybeans, rye, oats and vetch, and cotton in a four-year rotation on Cecil sandy loam soil. (Central Station.)

FRUIT INVESTIGATIONS

121. Fruit variety studies, apples, peaches, plums, cherries, grapes, raspberries and strawberries for Mountain, Piedmont and Coastal Plain regions.
122. Apple pruning studies.
123. Fertilizer requirements for apples.
124. Fruit breeding studies for the establishment of improved varieties and strains.
125. Tests of the adaptability of ornamental flowering plants and shrubs to the soil and climatic conditions of North Carolina.
126. Rotundifolia Grapes: Hybridization with other species.
127. Rotundifolia Grapes: A study of quality character.
128. A study of factors influencing the quality of fruits and vegetables in storage.
129. Orchard management in relation to annual and alternate bearing of pecans.
130. Tree performance of bearing pecans.
131. Yield, grade and quality in the strawberry as affected by cultural and fertilizer practices.
132. A study of food storage in the dewberry as influenced by pruning and fertilization, and its relation to growth and fruit production.
133. A study of the carbohydrates and nitrogen reserves by the peach tree in relation to growth and reproduction.
134. A study of food storage in the dewberry as influenced by pruning and fertilization, and its relation to growth and fruit production.
135. Fertilizer and lime requirements for strawberries grown on Norfolk fine sandy loam soil. (Coastal Plain Branch Station.)
136. Fruit breeding studies for the establishment of improved varieties and strains.
137. Study of fruit bud formation in relation to annual and alternate bearing in the pecan.
138. A study of soil conditions in the Chadbourn area that have been unfavorable to the growth and production of strawberries.
139. A study of food storage in the dewberry as influenced by pruning and fertilization, and its relation to growth and fruit production.
140. Dewberry diseases:
    (1) The cause of blight and measures of control.
    (2) The cause of root rot and measures of control.
    (3) A more efficient control for leaf spot and anthracnose.
141. Study of the relation of pruning, thinning, soil moisture and soil fertility to growth and fruiting of the peach in the Sandhill region of North Carolina.

TRUCK CROPS

142. Observation garden and trial grounds for the testing of new strains and varieties of truck crops. (Coastal Plain, Piedmont and Mountain regions.)
143. The fertilizer requirements of truck crops grown in rotation.
144. A study of lettuce "tipburn" with special reference to the resistance of selected strains.
145. Potato breeding with special reference to the selection of seedling strains that are better adapted to the State from the standpoint of blight resistance, earliness and yield.
146. A study of the influence of supplementing concentrated fertilizers with magnesia and other rare elements, when used for the fertilization of sweet potatoes on Norfolk loamy fine sand, Currituck County.
147. Fertilizer requirements of early Irish potatoes on Bladen fine sandy loam. (Outlying fields Beaufort County.)
148. Fertilizer and lime requirements for Irish potatoes, wheat and soybeans when grown in rotation on Toxaway loam. (Mountain Branch Station.)
149. Potato breeding with special reference to the selection of seedling strains that are better adapted to the State from the standpoint of blight resistance, earliness, and yield.
150. A study of factors influencing the quality of fruits and vegetables in storage.
151. Sweet potato diseases in storage and transit, with special reference to their control with chemical treatment.
152. Sweet potato diseases with special reference to the prevention of field infection.
153. Sweet potato disinfection studies for the control of seed borne fungi that cause heavy losses in the field.
154. Sweet potato diseases with special reference to their causal organisms.
155. Peach bacteriosis.
156. A chemical control study of wilt diseases caused by *Fusarium lycopersici* and *Bacterium solonacearum*.
157. A study of corn earworm with reference to its control by natural and applied means.,
158. A study of control measures for the Harlequin bug.

STANDARD OF LIVING STUDIES

159. A study of community facilities upon farm family living conditions among white owner and tenant farmers in Wake County, N. C., 1929.
160. A case study of factors in the family organization conditioning the living of farm owners in Wake County, North Carolina.

SOILS

161. The classification and mapping of North Carolina soils as a basis for soil fertility investigations and crop adaptation and other phases of land utilization.

162. A study of the chemical composition of certain soil types of the State. (Central Station.)
163. The development and classification of the Durham series of soils. (Central Station.)
164. Magnesia deficiencies of some representative sandy soil types of North Carolina.
165. A study of muck soils with reference to factors which limit crop production. (Blackland Branch Station.)
166. A study of depth of breaking and methods of culture in relation to crop stand and yields on peat soil. (Blackland Branch Station.)

FARM MANAGEMENT AND MARKETING

167. Methods and practices in the production of cotton and tobacco.
168. Study of organization and management of farms operated by cropper labor.
169. Cotton grade and staple estimates and primary market price studies.
170. Organization and practices of coöperative marketing organizations in North Carolina.
171. Farm organization and management in Johnston, Wayne and Wake counties.

FARM MACHINERY

172. The efficiency of 1, 2, 3 and 4-horse implements as compared with a tractor and plowing outfit.
173. Efficiency of one-horse and two-horse cultivators in cotton production. (Central Station.)

FIFTY-THIRD ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

FOR THE

YEAR ENDING JUNE 30, 1930

R. Y. Winters, Director

The workers of the Experiment Station are engaged in finding and publishing facts which are useful to farmers. These facts may be results of simple tests, they may be conclusions from years of more careful study, or they may be facts gathered by other institutions that have been tested under North Carolina conditions.

The work of the past year has been marked by the organization of groups of workers for a more thorough study of a few problems that are important to the agriculture of our State. Experience has taught that unfavorable conditions surrounding an agricultural enterprise may be due to several causes. The isolation and study of a single probable cause may lead to incomplete or even faulty conclusions. A review of the problem by workers in related fields of research usually results in a more complete consideration of the probable causes and suggests more thorough procedure for solving the problem. In the search for a solution of the problem each coöperating worker assumes responsibility for a definite segment of the project with a clearly stated objective.

NEW WORK

The coöperation of agencies outside of the Station has made possible the starting of a few new projects and the extension in scope of certain projects already under way.

The coöperation of the Division of Agricultural Engineering of the U. S. Department of Agriculture has made possible a more thorough study of farm management problems, with special reference to the influence of farm layout, protection against soil erosion, more adequate buildings and equipment upon the farm business.

New work has been started in the Chadbourn area of Columbus County for the study of soil conditions which have been unfavorable to the production of strawberries. This work is being done in coöperation with the Bureau of Chemistry and Soils of the U. S. Department of Agriculture.

As the results of research establish valuable facts, the testing of these facts under farm conditions becomes equally important. During the past year the research group in poultry diseases have coöperated with workers of the State Department of Agriculture in applying newly discovered facts for the control of white diarrhea among fowl. A more complete report of this work is contained in the report of the Poultry Department.

The completion and publication of a portion of the studies for the control of sweet potato diseases has made it possible to start new work for the control of tobacco and tomato wilt.

Soil Erosion Studies

Cultivated and open idle lands in all sections of the State are subject to losses by washing. This is particularly true of the Piedmont region because of the large acreage of hilly and sloping land in cultivation. The money value of the loss from this source is difficult to estimate since it not only consists of thousands of acres of gullied fields, but also large areas from which has been removed millions of tons of the surface soil. Add to this the filling of power reservoirs and stream beds with its accompanying impairment of natural drainage and one faces a problem which has already seriously handicapped our agriculture, and will in the near future become a serious problem to hydro-electric power developments.

No. 11135. STATESVILLE EROSION FARM, JUNE 17, 1930
Showing condition of land on west Coulter place lying between Moore and Little farms. This field had been idle for two years.

Work on the problem has been made possible by a congressional appropriation to the Bureau of Public Roads and the Bureau of Chemistry and Soils of the United States Department of Agriculture for the establishment of a Soil Erosion Station in the Southeastern states. North Carolina is very fortunate in having been selected for the location of this Station. After visiting all of the counties of the Central Piedmont region and examining possible sites, a farm of 270 acres located approximately eleven miles west of Statesville, N. C., on Highway No. 10, was selected for this work. This farm was made available for the studies by the Statesville Chamber of Commerce and by coöperating citizens of Iredell County.

A brief outline of the purposes of the research work now being installed at this station has been made by the National Committee on Soil Erosion.

Program of Research for Soil Erosion Field Station

1. "Study of run-off water and eroded material from varying slopes and soils to determine the plant food, organic matter, and soil losses, both dissolved and suspended. These studies to be made on both control plats and large field plats undergoing treatment for erosion control and water conservation.

2. Study of the effects of various soil treatments and covers on soil porosity, water absorption, leaching and evaporation.

3. Investigations on different slopes and soils to determine:
   (a) The rate of run-off and amount of erosion from terraced and unterraced lands.
   (b) The effects of varying the vertical and horizontal intervals between terraces upon the run-off and rate of erosion.
   (c) The effects of varying the grade of terraces upon the rate of soil erosion.
   (d) The maximum permissible length of terraces with uniform or variable grade on different slopes and soils.
   (e) Means of preventing erosion at the ends of terraces.
   (f) The effectiveness of terraces in conserving soil moisture during years of limited rainfall.
   (g) The conditions under which various types of soil-saving dams built of different materials are most effective in correcting gullied lands.
   (h) The most economic methods of constructing terraces and soil-saving dams with different types of equipment and to devise more effective methods of construction and more efficient equipment.
   (i) The most effective methods of maintaining terraces and soil-saving dams.
   (j) The effect of terraces on farm operations and upon modern farm machinery when used on contours and across the terraces.
   (k) The effect of cultural operations upon erosion and the possibility of preventing or diminishing by improved methods.
   (l) The effect of various cover crops in reducing or preventing erosion when these are used in conjunction with terraces and without terraces.

4. Study of crop yields resulting from the treatments.

5. Study of the moisture behavior—absorption, percolation, depth of penetration, circulation, retention, and evaporation—as affected by various treatments, temperatures, salt content, in the control and experimental plats, and experimental fields.

6. Field studies of physical properties in relation to erosion in the vicinity of the station.

7. Study of the disposition of erosional debris in the vicinity of the station.

8. Study of effect of run-off from eroding and non-eroding areas at or near station upon flood peaks, flood duration, and volume of water passing down the smaller streams.

9. Extend the survey of the relation of forest and range vegetation to watershed protection, erosion control and floods to other areas in the United States than the Mississippi Valley.

10. By test plots under controlled conditions determine the relation of intensity of rainfall falling on different degrees and character of vegetation upon the character, amount and rapidity of surface and sub-surface run-off and upon erosion.

11. On experimental areas determine the influence of vegetative cover, (Timber, brush, or herbaceous growth) and its depletion or removal by fire upon the character and amount of run-off and erosion.

12. Determine ways and means of preventing further erosion by reestablishing depleted timber, herbaceous or shrubby vegetation and/or replacing present vegetation with species that are of more value for watershed protection because of fire resistance."

The results of this program should be of benefit to the agriculture of all sections of our State for they apply not only to the conservation and restoration of farm lands in our Piedmont and Mountain regions, but have a direct bearing upon portions of our Coastal Plain region that are subject to overflow and poor drainage.

The agencies coöperating in this project are the Divisions of Agricultural Engineering and Soil Investigations of the U. S. Department of Agriculture, the North Carolina Department of Agriculture and the North Carolina Agricultural Experiment Station.

The extent to which the results of this work will benefit North Carolina depends upon our contribution in support and technical personnel. The Federal Department of Agriculture is supporting the project liberally, but their responsibility extends over the entire nation. The results from the proposed studies will undoubtedly yield valuable information. Their application to farm practice will be a responsibility of State agencies. At present our Experiment Station does not have competent contact with this work because of lack of technical personnel and maintenance funds.

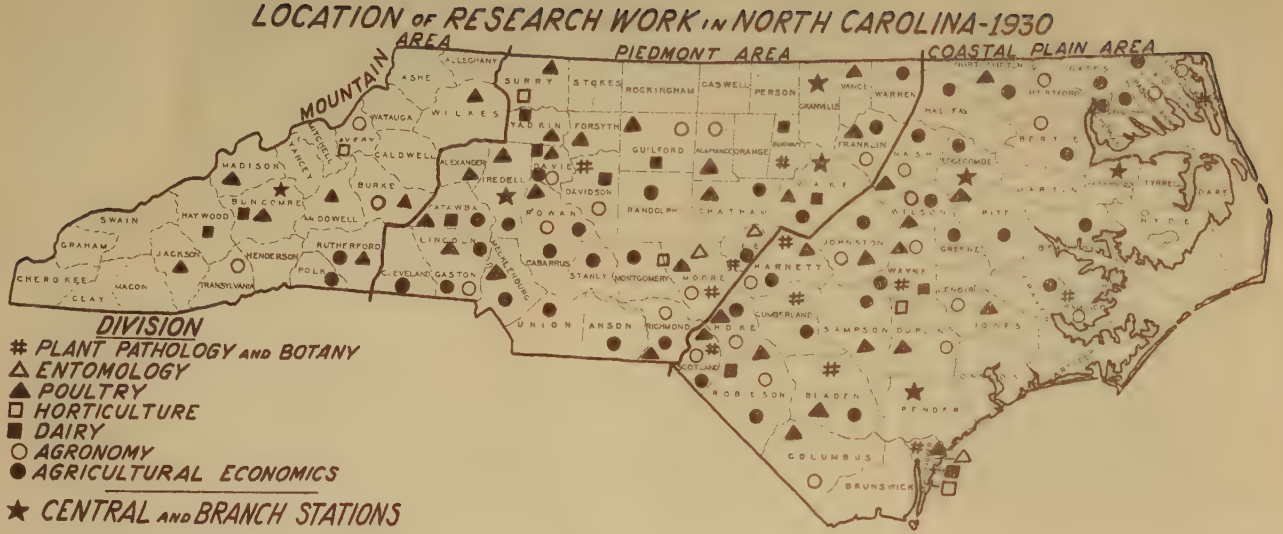
NEW APPOINTMENTS

The marketing research of the Department of Agricultural Economics has been materially strengthened by the appointment of Dr. Joseph G. Knapp as associate in marketing. Dr. Knapp was formerly connected with the Institute of Economics at Washington, D. C.

SCOPE AND DISTRIBUTION OF THE RESEARCH PROGRAM

The present scope of the research program has arisen from unfavorable conditions surrounding the major farm enterprises, the need for new and undeveloped enterprises and from more or less temporary emergencies. Much time and money must be expended each year patching the results of poor farming. In times of high prices it is very natural to neglect practices that are essential to good farm management. The present economic conditions confronting cotton and tobacco growers will help to revise the cropping system and make adjustments in livestock. These changes will make possible further shifts in the scope of research.

The distribution or location of research activities in the State is determined by the location of the central laboratories and farm at the College, the branch stations of the State Department of Agriculture and outlying temporary fields. The work at the Central Station consists of laboratory studies


LOCATION OF RESEARCH WORK IN NORTH CAROLINA-1930
MOUNTAIN AREA
PIEDMONT AREA
COASTAL PLAIN AREA
ALLEGHANY
ASHE
SURRY
STOKES
ROCKINGHAM
CASWELL
PERSON
VANCE
WARREN
WATAUGA
WILKES
YADKIN
FORSYTH
GUILFORD
ALAMANCE
ORANGE
FRANKLIN
HALIFAX
MITCHELL
AVERY
YANCEY
MADISON
CALDWELL
ALEXANDER
IREDELL
DAVIE
DAVIDSON
RANDOLPH
CHATHAM
WAKE
NASH
EDGECOMBE
BERTIE
BURKE
CATAWBA
ROWAN
BUNCOMBE
SWAIN
HAYWOOD
McDOWELL
LINCOLN
CABARRUS
STANLY
MONTGOMERY
MOORE
HARNETT
JOHNSTON
WILSON
PITT
MARTIN
TYRRELL
DARE
HYDE
GRAHAM
JACKSON
HENDERSON
RUTHERFORD
POLK
CLEVELAND
GASTON
MECKLENBURG
UNION
ANSON
RICHMOND
SCOTLAND
CUMBERLAND
HOKE
SAMPSON
DUPLIN
WAYNE
GREENE
LENOIR
JONES
CHEROKEE
MACON
CLAY
TRANSYLVANIA
ROBESON
BLADEN
PENDER
COLUMBUS
BRUNSWICK
DIVISION
PLANT PATHOLOGY AND BOTANY
△ ENTOMOLOGY
▲ POULTRY
□ HORTICULTURE
■ DAIRY
○ AGRONOMY
● AGRICULTURAL ECONOMICS
★ CENTRAL AND BRANCH STATIONS

and analysis and publication of data secured from work at the branch stations and outlying fields. The branch stations are distributed in seven areas of the State and are used to study farm problems peculiar to the regions in which they are located. From time to time problems arise at various points and under conditions that are not represented at the Central or branch stations. Tobacco diseases must be studied in the locality where they are most destructive; acute soil deficiencies must be studied where they occur; and unfavorable conditions surrounding such crops as peaches, potatoes and truck crops can best be studied on typical farms where the results will apply. The accompanying map indicates the distribution of farm studies that are attempting to solve some of our many problems and the following list of projects will give some idea of the scope of the work.

DIVISION OF PUBLICATIONS

The Division of Publications concerns itself primarily in releasing to the press of North Carolina timely and authoritative information based on research work conducted by members of the Station staff and in the editing and printing of the bulletins and circulars prepared by Station members.

During the past year, there has been a significant increase of interest in scientific research and the Division has found that when the results of these investigations are properly prepared and presented, they will be eagerly accepted for printing by the newspapers and will be read by a large percentage of the reading public.

Another of the large daily newspapers has added a farm page this year. This paper, *The Greensboro Daily News*, serves a large clientele throughout the piedmont section and prints a full page of timely farm news each Monday morning.

The press releases from this division are issued once a week, on Thursday, to the weekly newspapers of North Carolina, and every day in the week to the daily papers through the services of the Associated Press, the United Press, and Raleigh newspaper correspondents. By this means, the workers in the Division feel that the research work of the Station has been presented in a more satisfactory manner this year than in any previous period. We have definitely adopted the plan of sending one special feature story every Wednesday to six of the larger dailies. These articles are generally used as a feature on the farm pages the following Monday morning. A large percentage of the articles have been prepared by research workers.

Attention should be called here to the excellent support which has been given this division since July 1 by the Poultry Department. This department has attempted a regular schedule of timely articles dealing with various phases of the poultry industry. Fully 50 per cent of these articles have been based on research work and they have been widely used by every paper to which they have been sent.

Another service which the division attempts to render to the Experiment Station has been the advertising of publications as issued. A short item, giving an abstract of the publication is mailed to agricultural magazines, weekly newspapers and daily newspapers. The attention of the reading public is thus called to the fact that copies of these publications may be

had free of charge by citizens of North Carolina on application to the Division.

Extension Farm News, the house organ of the Extension Service, is also used for the purpose of distributing results of experimental research. This magazine goes to all extension workers including the county home and farm agents, all research workers, vocational teachers, boards of agriculture, and others engaged in the promotion of a better agriculture in the State. Around 3,500 copies of the *Farm News* is printed and distributed each month.

According to the records in this office, eleven experimental bulletins of the Station were printed and distributed during the fiscal year ending June 30, 1930. The total edition amounted to 29,500 copies. Of this number 12,716 copies were distributed to a regular mailing list consisting of libraries, station directors, farm and home agents, vocational teachers, and to selected mailing lists of those interested in the subject matter discussed in a particular bulletin.

It is a source of gratification to this Division that Technical Bulletin 38, "A Chemical Control of Sweet Potato Scurf," by Dr. R. F. Poole, of the Department of Botany, was awarded the blue ribbon for being the best technical bulletin published in the United States during the last fiscal year. This award was made at the last annual meeting of the American Association of Agricultural College Editors, held in Washington, D. C., this summer.

The fifty-second annual report was issued in an edition of 1,500 copies and distributed to libraries, station directors and workers both in North Carolina and other states.

In addition to these current publications for the year, individual requests from farmers and agricultural workers for bulletins and other informational matter issued prior to this year have been handled. The requests for the year have amounted to 61,578, making a grand total of 75,794 bulletins mailed from this office this year.

The division has also been responsible for much service work. The assistant editor has given a considerable part of his time to looking after the printing of report forms, letterheads, envelopes, and other small printing needed for the Experiment Station staff. A total of 56,465 circular letters have been mimeographed or multigraphed for the Station workers, and 13,450 of these have been mailed directly from the office. A permanent mailing list is maintained for the Station and is subdivided under subject matter heads. Much time has been spent with the heads of the various departments in going over proposed publications, advising as to the use of cuts, graphs, maps, and type sizes.

The complete report of publications printed and distributed by the Experiment Station for the year ending June 30, 1930, is as follows:

GENERAL BULLETINS

No.	*Title*	*No. Copies*
268.	Control of Oat Smut by Seed Treatment	3,500
269.	Farm Family Living in Wake County	2,000
270.	Farm Credit in North Carolina	3,000
271.	Credit Problems of N. C. Cropper Farmers	3,000
272.	Cost of Raising Pigs to Weaning Age	3,000
273.	A Chemical Control for Sweet Potato Wilt or Stem Rot	3,000
274.	A Control for Sweet Potato Scurf	3,000
275.	Migration of Sons and Daughters of White Farmers in Wake County, 1929	3,000

REPORTS

52.	Annual Experiment Station Report 1928-29	1,500

TECHNICAL BULLETINS

37.	Factors Influencing Living Conditions of White Owners and Tenant Farmers in Wake County	2,000
38.	A Chemical Control of Sweet Potato Scurf	4,000

TECHNICAL PAPERS

34. The "Laws" of Serologic Race-Classification.
L. H. Snyder.
35. A New Species of Nemobius from North Carolina.
B. B. Fulton.
36. Availability of Manganese and of Iron as Affected by Applications of Calcium and Magnesium Carbonates to the Soil.
H. B. Mann.
37. Social Mobility Among Farm Owner Operators.
W. A. Anderson.
38. The Relation of Evaporation to Killing Efficiency of Soap Solutions on Harlequin Bug and Other Insects.
B. B. Fulton.
39. Notes on Oregon Orthoptera with Descriptions of New Species and Races.
B. B. Fulton.
40. The Feeding of Cottonseed Meal to Dairy Cattle.
C. D. Grinnells.
41. Ammonium Calcium Balance—A Concentrated Fertilizer Problem.
L. G. Willis.
42. A Contribution to the Knowledge of Neotropical *Megachile*.
T. B. Mitchell.

AGRONOMY INFORMATION CIRCULARS

(1) No. 27. Some of the more outstanding research results in Agronomy of the N. C. Agricultural Experiment Station, by C. B. Williams.

(2) No. 28. List of North Carolina Agronomy Research publications, by C. B. Williams.

(3) No. 29. Preliminary report on two years' fertilizer experiments with early Irish potatoes on the farm of A. W. Baker, Aurora, Beaufort County, N. C., by J. J. Skinner, C. B. Williams and H. B. Mann.

(4) No. 30. Results of wheat variety tests at the Piedmont branch station farm, by G. M. Garren.

(5) No. 31. Outline of fertilizer demonstrations with wheat in North Carolina for county agents, by C. B. Williams.

(6) No. 32. Outline of fertilizer demonstrations with cotton in North Carolina for county agents, by C. B. Williams.

(7) No. 33. Outline of cotton fertilizer field projects on Coastal Plain and Piedmont soils of North Carolina for schools of vocational agriculture, by C. B. Williams.

(8) No. 34. Fertilizer recommendations for important crops of Agricultural Regions No. 1, by C. B. Williams, H. B. Mann and A. S Cline.

(9) No. 35. Fertilizer recommendations for important crops of Agricultural Region No. 2, by C. B. Williams, H. B. Mann and A. S. Cline.

(10) No. 36. Fertilizer recommendations for important crops of agricultural region No. 3, by C. B. Williams, H. B. Mann and A. S. Cline.

(11) No. 37. Fertilizer recommendations for important crops of agricultural region No. 4, by C. B. Williams, H. B. Mann and A. S. Cline.

(12) No. 38. Fertilizer recommendations for important crops of agricultural region No. 5, by C. B. Williams, H. B. Mann and A. S. Cline.

(13) No. 39. Fertilizer recommendations for important crops of agricultural region No. 6, by C. B. Williams, H. B. Mann and A. S. Cline.

(14) No. 40. Fertilizer recommendations for important crops of agricultural region No. 7, by C. B. Williams, H. B. Mann and A. S. Cline.

(15) No. 41. Fertilizer recommendations for important crops of agricultural region No. 8, by C. B. Williams, H. B. Mann and A. S. Cline.

(16) No. 42. Summary of results of cotton variety experiments conducted during 1927, 1928 and 1929 and production and consumption of different staple lengths, by P. H. Kime.

(17) No. 43. Varieties of cotton being recommended by county agents and vocational teachers of North Carolina, by P. H. Kime.

(18) No. 44. Corn varieties recommended for North Carolina growers, by G. M. Garren.

(19) No. 45. Timely suggestions for burley tobacco growers by E. Y. Floyd.

(20) No. 46. Important factors in cotton growing in North Carolina, by P. H. Kime.

(21) No. 47. Improved practices for producing tobacco of better quality, by E. Y. Floyd.

(22) No. 48. How farmers of the State may have their soils examined and appraised, by C. B. Williams.

(23) No. 49. I—Factors in soybean production. II—Variety recommendations and characteristics, by P. H. Kime.

(24) No. 50. Painting and whitewashing on the farm, by D. S. Weaver.

(25) No. 51. How the North Carolina Soil Survey is being used to help farmers, by C. B. Williams.

F. H. JETER,
Agricultural Editor.

RESEARCH IN AGRICULTURAL ECONOMICS

Research in agricultural economics during the year ending June 30, 1930 was conducted along the lines outlined in last year's annual report. Attention, however, has been given primarily to farm organization and the marketing of agricultural products. The projects on farm credit started two years ago were completed during the year and the results published in two bulletins entitled "Farm Credit in North Carolina Its Costs, Risks and Management" Station Bulletin No. 270, and "Credit Problems of North Carolina Cropper Farmers" Station Bulletin No. 271. The active projects are:

1. Farm Organization and Management in Wake County.
2. Methods and Practices in the Production of Cotton and Tobacco.
3. A Study of Organization and Management of Farms Operated by Cropper Labor.
4. Grade and Staple of North Carolina Cotton.
5. Cotton Marketing and Price Study.
6. Consumption and Production of North Carolina Cotton.
7. Coöperative Marketing Activities.

FARM ORGANIZATION AND MANAGEMENT

RALPH H. ROGERS

Associate Agricultural Economist, in Charge of Investigations

For a number of years the Department of Agricultural Economics has been engaged in research relative to the organization and management of farms in typical agricultural areas of the State. The first project was started in 1924 and completed in 1925. The results of this investigation were published in Research Bulletin No. 1. In 1925 a similar project was formulated for the Lower Coastal Plain. Specifically, the data were collected in Craven County. The results of this study were published in 1927 in Station Bulletin No. 252 entitled "Profitable Farm Combinations." The work was continued in 1926 in Macon County, the agriculture of which is typical of the mountain areas. The results of this study were published in 1928 as Station Bulletin No. 260, "Systems of Livestock Farming for the Mountain Region of North Carolina." Investigations on the farm organization and management problems in the northeast Coastal Plain were begun in 1927, with Northampton County being selected as the site for this study. The results have been tabulated, analyzed and a manuscript prepared. At the present time, the farm management problems of the Piedmont area are being investigated. This work is located in Wake County.

As pointed out in our report of last year, the major objective of these farm management investigations is to determine for each important area of the State the combinations of crops and livestock which will yield the maximum long-time net returns. The combinations which have been suggested and presented in the various bulletins mentioned above have followed closely the organization and management of the most successful farms in the areas studied. In determining the net returns for these suggested organizations, normal yields and prices have been used rather than average

yields and prices, or yields and prices for any particular year. This has been deemed advisable because a farmer in organizing his farm must do so on the basis of normal conditions. Minor changes in the organization may be made in light of anticipated annual changes in conditions, but fundamentally an organization must be built on yields and prices which are likely to be obtained over a period of years. These suggested systems of crop and livestock enterprises will furnish, it is believed, a practical guide to farmers in reorganizing their farms, and enable them to obtain through reorganization a better use of their resources.

Farm Management in the Piedmont Area. The Wake County project was begun in 1929. During the first year 16 farmers coöperated in keeping complete or partial records of their farm business. Several of these farms have been selected for a more detailed study with the view of aiding them to reorganize their farms and to check the results of such reorganization. It is planned, before publication of the Wake County material, to conduct a general farm management survey of several dairy farms which supply milk to Raleigh and also some general farms in Wake County for the purpose of expanding the information obtained during 1929. The preliminary results of this study will be published in the near future, but the final results may not be available for several years, as it will take time to work out the plans of reorganization and to induce farmers to make the necessary changes. Six of the Wake County farms and seven in Johnston and Wayne counties form a basis of an additional study in the reorganization of the farms which is being conducted in coöperation with the Bureau of Public Roads.

Methods and Practices in the Production of Cotton and Tobacco. This project was inaugurated February, 1930. The fundamental object of this project is to get material which will enable farmers to improve the methods and practices used in the production of these crops. To obtain the basic information, 36 farmers in Wayne and Johnston counties are keeping complete records on cotton production involving about 480 acres of cotton. These records provide for detailed information regarding the labor expended on cotton according to operations such as plowing, discing, picking, etc.; the yield, the amount of fertilizer and other material used in the production of the crop. In addition to the primary information an attempt is being made to obtain, in the case of each farmer, the reasons why certain practices and methods are used. The object of this is to discover, if possible, to what extent farmers rely on information as published in bulletins, papers, etc., as guides in the production of their crops and to what extent they depend upon custom and tradition.

To obtain all the data which are needed to determine the cost of producing cotton and tobacco, it is necessary to have complete records on typical farms. In addition, therefore, to the records on cotton production, 16 of the 36 coöperators are keeping detailed financial records on the farm business as a whole. At least three years or longer will be required to complete this project in a satisfactory manner and to check the results of suggested changes in methods and practices. During 1931 the work will be expanded to include methods and practices used in the production of tobacco.

Farm Reorganization Study. This project is being conducted in co-operation with the Bureau of Public Roads of the U. S. Department of Agriculture. The purpose of the study is to determine the economic benefits to be secured on typical farms in the eastern Piedmont and western Coastal Plain area of North Carolina by means of a better physical development of farms, a better planned farming system and the use of modern equipment. Thirteen farms, six of which are located in Wake County and seven in Johnston and Wayne counties, have been mapped in a very detailed fashion

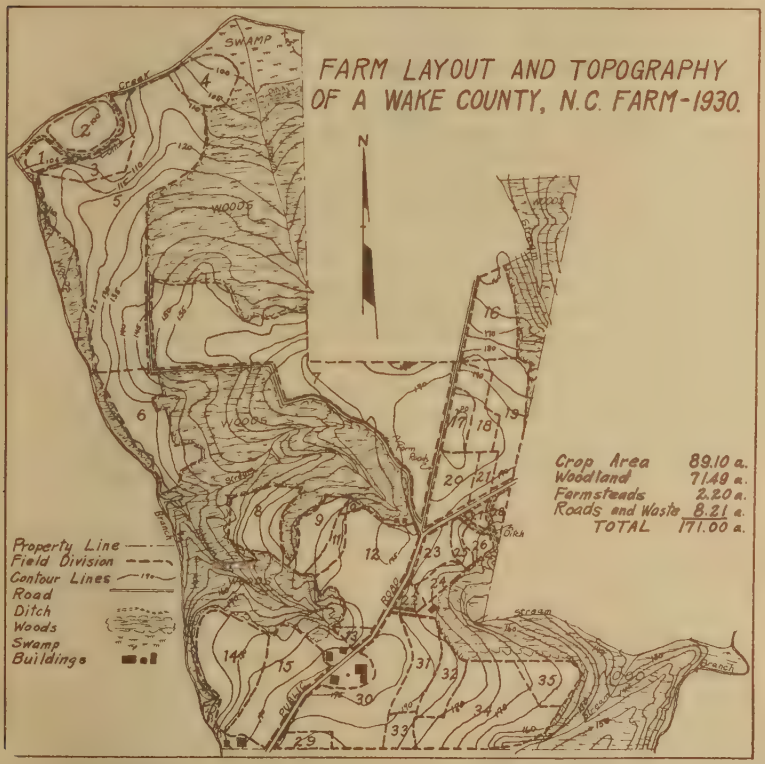


Fig. 1.—A detailed map of one of the farms being studied in Wake County. In 1930 this farm had 35 fields averaging 2.5 acres in size. No crop rotation system was followed. The reorganized plan calls for three 5-acre fields to accommodate a 3-year tobacco rotation, three 15-acre fields for the major rotation of cotton, corn and legumes; and two 10-acre fields for a minor rotation of corn and soybeans and small grain. A rotated hog pasture is also provided. The new plan requires 11 fields instead of 35 and establishes a definite cropping system.

by the Bureau of Public Roads. On these maps are shown the field divisions, crop areas, waste land, wood land, location of the buildings, etc. In addition to the foregoing, the maps show the present terraces, drainage lines and contour lines. The contour lines have been run at five foot intervals, and show the topographical features and indicate the possibilities of improving the farm layout. It is planned, after the first year's work, to develop for

these farms a better farm layout as well as farming systems which will utilize to better advantage the farmers' available resources. The Bureau of Public Roads will assist in this work especially in estimating the cost necessary for the important changes which must be made in the farm layout, as well as making suggestions as to the modern equipment necessary for economic production. When these plans are perfected, they will be presented to the farmers who are coöperating and an earnest effort will be made to get them to make the necessary changes in their farm organization and management. This is a long-time project, as it will take several years to perfect the plans and to get the farmers to make the necessary changes. The results of this experiment will be available to other farmers in the area to which the study applies and they by reading the results, may make the changes in their own organizations which seem most desirable.

The Organization and Management of Cropper Farms. The first part of this study dealing with the financial aspects of cropper-operated farms has been completed and the results published in a bulletin entitled "Credit Problems of North Carolina Cropper Farmers." The second part dealing with the actual organization and management of the cropper-operated farms is being developed. This study, when completed, will show how typical cropper-operated farms located in the Coastal Plain of North Carolina are organized and managed. The results will also show the cost of operating these farms and the normal net returns. In addition, it is planned to suggest systems of organization which will utilize more completely the available resources than existing organizations do. Much work has already been done on this project and a manuscript will be prepared during 1931.

Cost of Producing Strawberries. This project was started two years ago in coöperation with the U. S. Department of Agriculture and several strawberry producing states. The field work was completed in 1928. During the past year the data have been tabulated, analyzed and the first draft of a bulletin prepared. A copy of the manuscript has been sent to the various states coöperating, for criticism and suggestions. A bulletin no doubt will be published during the year by the U. S. Department of Agriculture. This bulletin will cover all the important facts relative to strawberry culture in the important strawberry producing areas in the southeastern states.

Cost of Producing Farm Products. Over a period of several years the Department of Agricultural Economics has been collecting data on farm organization and management. These data, in addition to having been used for the purpose of suggesting standard systems of farming, are useful also for determining the cost of producing farm products. During the past year considerable work has been done in assembling this material, with the object of preparing a bulletin on the cost of producing North Carolina farm products. This bulletin will deal with the theoretical aspects of the subject as well as the practical application of the data. The information will show the physical requirements for the production of all the important products produced in this State, and the variation in requirements from farm to farm. The bulletin should be useful in assisting farmers in economizing their resources as well as giving better understanding of the use and nature of cost data.

INVESTIGATIONS IN THE MARKETING OF FARM PRODUCTS

JOSEPH G. KNAPP
Associate Agricultural Economist, in Charge of Investigations

Grade and Staple of North Carolina Cotton. Realizing that knowledge of grade and staple was necessary for further work in cotton marketing, the North Carolina Experiment Station in coöperation with the Division of Cotton Marketing, Bureau of Agricultural Economics, U. S. Department of Agriculture, undertook two years ago an extensive study of this project. The basic data relative to grade and staple of cotton produced in this State were obtained through the coöperation of representative ginners. From the gins selected for study, samples were taken from all the bales ginned and classed according to official standards for grade and staple by a committee of specialists in cotton classing.

The grade and staple reports for the 46 different gins for the 1929-30 cotton crop are grouped (Table 1) into the three distinctive cotton producing regions shown in (Figure 2); namely the (1) Tidewater, (2) Upper Coastal Plain, and (3) Piedmont regions.

Region 1 shows a lower percentage of white middling and better cotton than do the other sections of the State. As to staple length this same region shows a larger average percentage of cotton under 7/8-inch, and a smaller percentage 15/16-inch and above. The data thus indicate that grade is lower and staple shorter in this region than in the other regions.

Region 2 has considerably more cotton than Region 1 of white middling and better grade, and less cotton with staple under 7/8-inch.

Region 3, the Piedmont area, has the largest percentage of cotton, white middling and better and the least amount of cotton under 7/8-inch in staple length.

TABLE 1

AVERAGE PERCENTAGES OF EACH GRADE AND STAPLE LENGTH GINNED IN NORTH CAROLINA BY REGIONS OF THE STATE 1929-30

	Grade			Staple Length			
Region	White Middling and Better	White S. L and L. M.	Other Grades	1 1/8" and Over	15/16" and 1 3/32"	7/8" and 29/32"	Under 7/8"
I	21.34	57.86	20.75	—	18.31	59.03	22.64
II	57.22	25.53	17.24	.21	26.17	64.93	8.67
III	68.81	10.20	20.19	.06	27.26	66.70	5.98

Consumption and Production of North Carolina Cotton. This project was designed for the purpose of obtaining detailed information on the nature of mill consumption of cotton and the character of the cotton produced in North Carolina. The information on mill consumption was obtained directly from mill operators of this State by questionnaires. The information on production was obtained from the U. S. Department of Agriculture. The preliminary data reveal in the case of 125 mills covering a three-year period

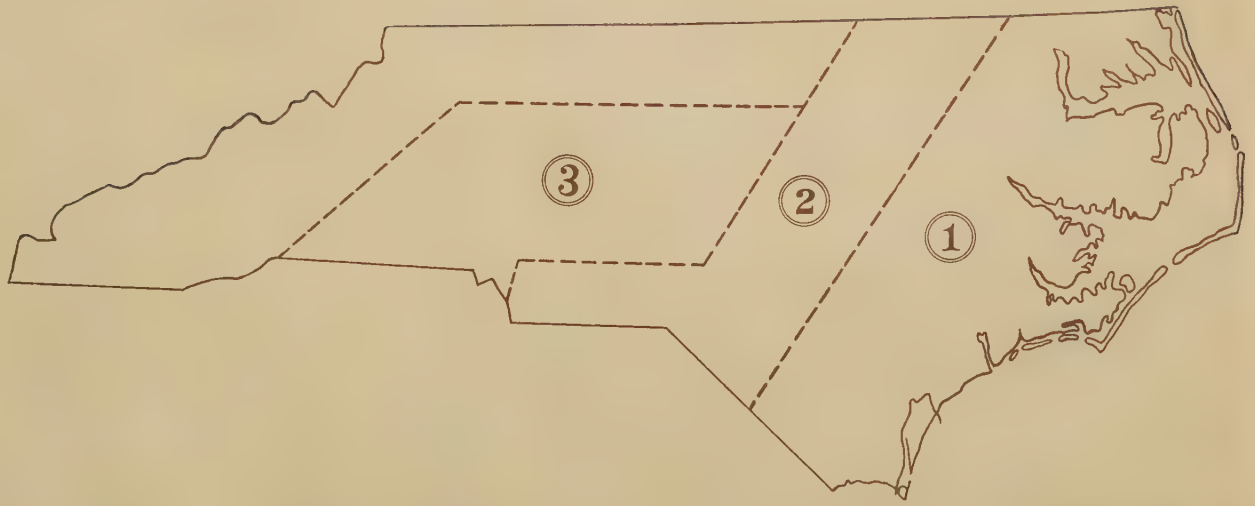


Fig. 2.—Cotton Producing Areas:
(1) Tidewater
(2) Upper Coastal Plain
(3) Piedmont

that approximately 70 per cent of their consumption of cotton was obtained from outside the State. This fact is readily explained when the mill requirements are compared with the character of our production. The comparison of these two sets of data shows that the State is producing a large amount of short staple cotton, while the mills in the State are consuming mostly cotton of longer staple lengths. These facts are presented in the following tabulations:

PERCENTAGE OF COTTON PRODUCTION AND CONSUMPTION IN STAPLE LENGTH GROUPINGS

	Production 1928-29	Consumption 1928-29
Under 7/8"	10.0%	2.2%
7/8" and 29/32"	69.4	24.5
15/16" and 1 1/8"	19.7	68.1
1 3/16" and over	.9	5.2
All Staple Lengths	100.0%	100.0%

Cotton Marketing and Price Study. The sources and methods used in obtaining the data for this study were described briefly in last year's annual report. These data on prices received by growers for cotton in eleven local markets in North Carolina in 1928-29 have been analyzed in collaboration with the Division of Cotton Marketing, Bureau of Agricultural Economics, U. S. D. A. The results show that prices received by growers in these local markets varied so irregularly during the periods studied that it was not unusual to find that some farmers received considerably higher prices for the lower grades and shorter staples than other farmers received for the higher grades and longer staples in the same markets on the same days.

The average premiums received by growers in these local markets for grades above Middling amounted to only a very small proportion of the premiums

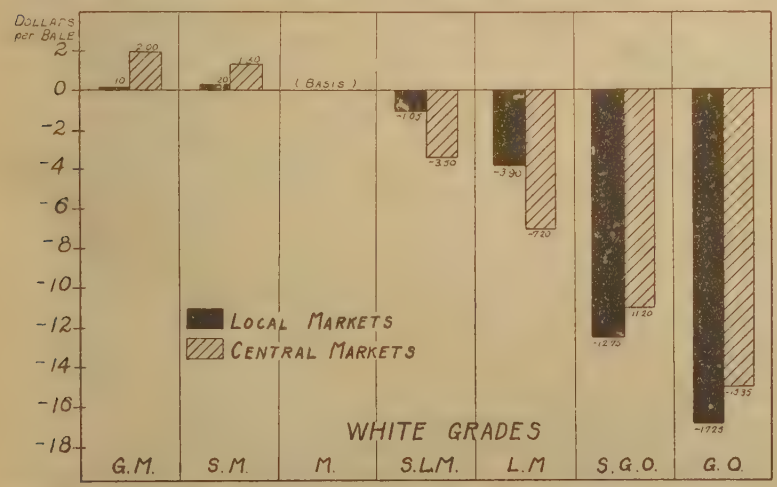


Fig. 3.—Average grade difference paid per bale for cotton in local markets in North Carolina and in central markets, Season 1928-29. Minus (—) means a discount.

TABLE 2

AVERAGE GRADE DIFFERENCES PAID[1] FOR COTTON IN LOCAL MARKETS IN NORTH CAROLINA AND IN CENTRAL MARKETS, AND COMPARISON OF DIFFERENCES PAID IN LOCAL MARKETS WITH THOSE PAID IN CENTRAL MARKETS, SEASON 1928-29[2]

White Grades[3]	Local Markets		Central Markets	Variations
	Size of Samples	A Average Differences	B Average Differences	A-B
	(Bales)	(Dollars)	(Dollars)	(Dollars)
3. Good Middling	89	0.10	2.00	—1.90
4. Strict Middling	1,584	.20	1.30	—1.10
5. Middling	2,455	0	0	0
6. Strict Low Middling	784	—1.05	—3.50	2.45
7. Low Middling	147	—3 90	—7 20	3.30
8. Strict Good Ordinary	32	—12.75	—11.20	—1 55
9. Good Ordinary	38	—17.25	—15.35	—1.90

[1]Prices expressed in dollars per bale of 500 pounds gross.
[2]Basis Middling white cotton=0. (Minus (—) means a discount.)
[3]Includes extra white cotton.

TABLE 3

AVERAGE STAPLE PREMIUMS AND DISCOUNTS PAID[1] FOR COTTON IN LOCAL MARKETS IN NORTH CAROLINA AND IN CENTRAL MARKETS, AND COMPARISON OF THE AVERAGE PREMIUMS AND DISCOUNTS PAID IN LOCAL MARKETS WITH THOSE PAID IN CENTRAL MARKETS, SEASON 1928-29[2]

Staple Length[3]	Local Markets		Central Markets	Variations
	Size of Sample	A—Average Premiums and Discounts	B—Average Premiums and Discounts	A—B
(Inches)	(Bales)	(Dollars)	(Dollars)	(Dollars)
13/16 and shorter	487	—0.55	—2.50	1.95
7/8	3,583	0	0	0
15/16	909	.15	1.35	—1.20
1 and 1 1/32	169	.25	4.10	—3.85
1 1/16 and 1 3/32	24	1.15	8.05	—6.90
1 1/8 and 1 5/32	11	2.00	10.85	—8.85
1 3/16 and 1 7/32	1	.80	15.25	—14.45
1 1/4 and longer	1	—1.15	26.25	—27.40

[1]Prices expressed in dollars per bale of 500 pounds gross.
[2]Basis 7/8 inch cotton=0. (Minus (—) means a discount.)
[3]All grades of white cotton.

for these grades paid in central markets. The average discounts received by growers for Strict Low Middling and Low Middling Cotton were considerably less than those paid in central markets, while the discounts for Strict Good Ordinary and Good Ordinary were somewhat greater in the local market studied than in central markets. (Table 2 and Figure 3.)

The average price received by growers for cotton with a staple length of 13/16-inch and shorter was only 55 cents per bale less than that received for 7/8-inch cotton, whereas in central markets cotton with a staple length of 13/16-inch and shorter was penalized $2.50 or more per bale. The premiums received by growers for staple lengths longer than 7/8-inch amounted to only a very small part of those paid in central markets. (Table 3 and Figure 4.)

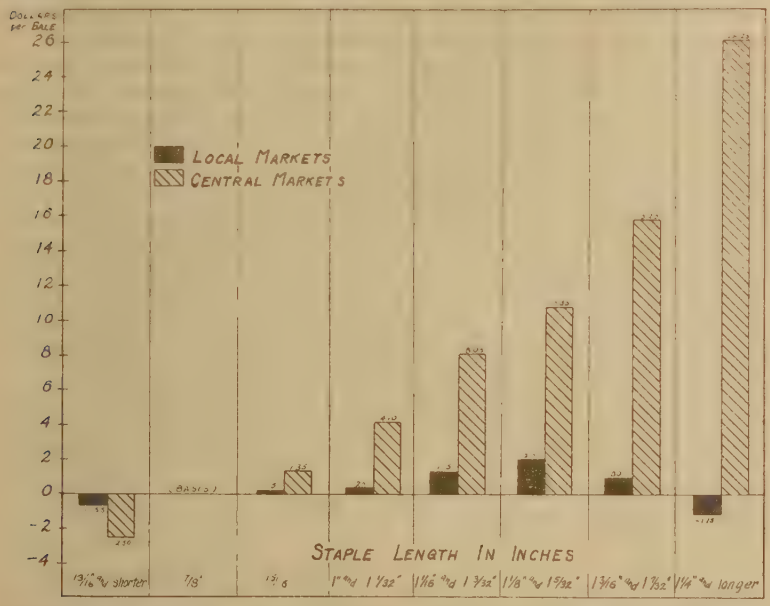


Fig. 4.—Average staple premiums and discounts paid per bale for cotton in local markets in North Caorlina and in central markets, Season 1928-29. (Minus (—) means a diesount.

In general, the average prices received by growers were higher in local markets where the cotton sold averaged higher in grades and longer in staple length than in local markets where the cotton sold average lower in grade and shorter in staple length. These differences in average prices indicate that growers were rewarded on a community basis for producing the higher grades and longer staple lengths and were penalized on a community basis for producing cotton of lower grades and shorter staple lengths. The failure to distribute these rewards and penalties on an individual bale basis offers a bonus to individual farmers for producing the kind of cotton responsible for the lower average prices and penalizes farmers for producing the kind of cotton responsible for the higher average prices.

On the farm pictured above, the cropping plan was as follows:

Crop	Acreage	Per Cent
Cotton	30.34	34.2
Corn	21.05	23.6
Tobacco	4.71	5.3
Hay	5.73	6.4
Vegetables	3.66	4.1
Idle	23.61	26.5
Total	89.10	100.0

Coöperative Marketing Activities. It is generally recognized that our present system of marketing farm products is defective. As a preliminary to a more intensive study of our marketing system as it affects the farmers, data were collected during the year of 1929-30 on the extent and nature of the State coöperative marketing activities. A partial survey of these activities shows that there is much coöperative marketing of an informal nature. In fact, according to reports received, there were over 100 instances of informal coöperative marketing carried on by farmers with the assistance of county agents and vocational teachers. Reports were received from 76 coöperative organizations in the State. Of these 43 were incorporated. These 76 associations may be classified roughly as folloys. livestock, 12; poultry, 13; mutual exchanges, 13; truck, 17; purchasing associations, 6; credit or financing associations, 1; farmers federations, 4; state-wide cotton coöperative association, 1; improvement associations (seed or soil), 3, and of miscellaneous character, 6. A more detailed study of these organizations is plenned with the view of getting accurate information relative to the nature of the organizations and the methods of operation. When this information is collected and analyzed, it should be helpful in strengthening the present coöperatives and in assisting in the formation of other needed coöperative associations in the State.

From the preliminary data obtained, it was possible to make an intensive study of two coöperative marketing associations in this State; namely, the North Carolina Cotton Growers Association and the Farmers Federation of Asheville. These two studies have been completed and are now in manuscript form. They shrow a great deal of light on the work that these associations are doing in this State.

G. W. FORSTER,
Head of the Dept. Agri. Economics.

RESEARCH IN AGRONOMY

During the year Agronomy research workers have devoted their efforts actively to the solution of some of the more pressing problems in soil chemistry and soil fertility, on crop rotation, plant breeding and to determine the best methods of seeding and cultivation of various economic crops of the State.

Work on the classification and mapping of soils of the different counties of the State has, as heretofore, gone forward aggressively.

In the soil chemistry work, the investigations have mainly centered on a study of the magnesium supplies of representative Coastal Plain soils and the factors which influence its availability to crops. Considerable time has also been devoted to a study of conditions causing unfavorable crop growth, with particular reference to cotton grown on Norfolk sand. The results thus far obtained have shed much light on these important soil fertility problems connected with the most economic production of crops on some Coastal Plain soils.

The results of field plat tests on the peat soils of the State have given striking indications of pecularities as to liming and fertilization that are not common to upland soils.

These pecularities are being investigated more in detail and the results now in hand promise a clearer understanding of the limitations of these soils if not a practical means of increasing crop yields.

The soil fertility field investigations, located on the Central and six branch station farms, have been continued along the same general lines as reported on in previous years. Outlying field work on various soil types in different parts of the State, mainly with cotton, corn, small grains, peanuts, soybeans, red clover, sweet potatoes and Irish potatoes, has been enlarged through special fellowship grants. Thirty new field experiments were started with cotton on eight soil types to study the value of ammo-phos as sources of phosphoric acid and nitrogen in a complete fertilizer. Seven outlying field experiments were started for the purpose of determining the effects of superphosphate upon the maturity of cotton, as indicated by the percentage open at the first picking. These, with the twenty-one regular outlying field experiments, make fifty-eight in all of this type of experiment on the farms of leading cotton growers in the main cotton-growing belt of the State.

In the regular soil fertility experiments on the Central and branch station farms, as well as on outlying fields, one of the chief purposes of the work from the standpoint of growers of the State, is to establish the main plant nutrient deficiencies of the soils of these fields for best and most profitable crop growth and to determine how best to meet these deficiencies for each crop. In these experiments, particular attention is being given to a study of the relative value of the more common organic and inorganic carriers of nitrogen in fertilizers used on different soils for various crops, especially for cotton, tobacco and corn.

The experiments designed to study the value of different systems of crop rotation on Norfolk sandy loam at the Upper Coastal Plain, on Cecil clay loam at the Piedmont, and on Toxaway loam and Porter's loam at the Mountain branch station farms have been continued. Results thus far secured have shown that the use of proper crop rotations, including legumes for soil improving purposes, coupled with the right kinds of fertilization, for each crop, have been effective, in many cases, in economically increasing the yield of major crops in the rotations.

The information supplied by the soil survey of the State and that from the soil fertility experiments have been jointly utilized in the preparation of a series of eight circulars giving specific recommendations for the proper fertilization of major crops grown on the different series of soils occurring in each of the eight agricultural regions. These recommendations are being used generally by growers of the State.

SPECIAL SOIL EXAMINATION SERVICE FOR FARMERS

The Department during the past three or four years, has maintained a soil identification and examination service for farmers and others. For each of the past two years, between twelve and fifteen hundred samples of soil have been examined. Before examination is made of any sample, a definite statement is secured from the owner with reference to the previous treatment of his soil; crops grown on it during the previous three years, with the fertilizer and lime treatments given; average yields secured; and any observed abnormalities of growth of crops on it. With this information at hand, coupled with data supplied by the examination in the laboratory and with results from field experiments on the same type of soil, it is possible for the Department to give definite and reliable directions as to what fertilizer, lime or other treatment is best for the soil under normal conditions. The soil examinations frequently indicate the need of a change in the crops grown on the same.

This service has been taken advantage of by large numbers of farmers, especially by those who are growing tobacco and cotton as major crops on their farms. It is not uncommon to have farmers drive into the Department from 100 to 150 miles bringing with them soil samples which they wish to have examined and appraised, and be advised as to the best analyses of fertilizers to use on them, as well as best sources of phosphoric acid, potash and nitrogen to purchase, and how and when to apply them for best results for their crops.

PROGRESS OF SOIL SURVEY OF THE STATE

The work in soil survey of the State, conducted in coöperation with the Federal Bureau of Chemistry and Soils, has progressed satisfactorily. Four men—two State and two Federal—have been engaged in the field work in mapping and classifying soils, and in preparing reports on the different areas being surveyed.

During the year, Macon and Montgomery counties have been finished; about three-eights of Brunswick completed; and work has gotten well under way in Franklin County. Up to the present time more than three-fourths

of the counties of the State have been finished and reports on them have been issued.

The reports prepared from these surveys have been in such demand by farmers, agricultural workers, and others that it has, in many cases, been impossible to meet calls for copies of them.

These detailed surveys are necessary for the State to provide an inventory of its soil resources and to afford agricultural workers in soil fertility and crop production fundamental information for definitely planning and carrying out their work in the interest of farmers of the State. They are also necessary for supplying fundamental information to farmers so that they can apply in a definite way on their own farms the results of findings of Agronomy research on soils and crops of the State.

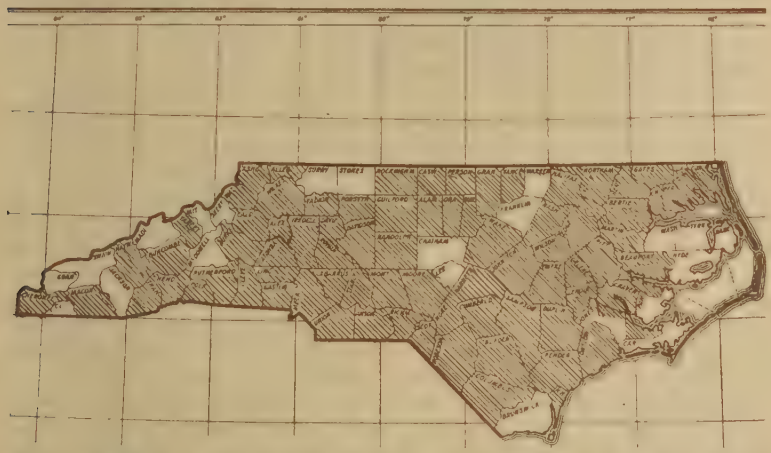


Fig. 1.—Showing by shading the areas and counties of North Carolina which have been soil surveyed.

FORMULATION OF TOBACCO FERTILIZER RECOMMENDATIONS FOR 1931

For a number of years this Department and the Agronomy Departments of Virginia, South Carolina and Georgia, and the Office of Tobacco Investigations of the U. S. Department of Agriculture, have been preparing and issuing each fall fertilizer recommendations for the benefit of tobacco growers, and fertilizer manufacturers and dealers of the bright flue-cured, sun-cured and shipping belts of these states. These recommendations have met with hearty response and are now being quite generally followed as a guide in the manufacture and purchase of fertilizers for tobacco grown in the four states.

The recommendations deal with the best amounts and proportions of plant nutrients to use per acre; best sources of phosphoric acid, ammonia and potash to use; and give directions for the practical incorporation of small amounts of magnesia and chlorine in the fertilizer mixtures for the most satisfactory growth and quality of this crop on all tobacco soils.

They are carefully formulated in conference from the collective experiences and observations of research and extension tobacco workers.

TECHNICAL SOIL PROBLEMS

Magnesia Deficiencies of Representative Sandy Soil Types of the Coastal Plain. The completion of three year's work on this project has resulted in an accumulation of data pointing to some interesting conclusions. If these data are substantiated by further work, they will be generally applicable to the types of soil used in the experiment. The results at hand support the following conclusions:

There is at present no distinct evidence in the analysis of drainage waters of a depression in the solubility of soil magnesium consequent to the addition of calcite limestone but the growth and magnesia content of soybeans grown on soils treated identically as were those in the lysimeters shows a decided depression in magnesia content as a consequence of heavy liming with calcite.

The effects of chloride and sulphate of potash on the solubility of native and added magnesia show no certain differences referable to the two sources of potash but soybean plants show some very striking effects of the added potash salts. Most important of these is the decided superiority of the sulphate which is assumed to indicate a serious sulphur deficiency in these soils. This has been evident since the second year. With this unforeseen deficiency as a factor, the results indicating differences in the magnesia content of the soybeans grown with the two sources of potash are not to be interpreted at this time with any great degree of confidence. There is, however, one point of difference distinct enough to appear significant. Plants grown with sulphate of potash contain greater amounts of magnesia than those with the chloride except where magnesia is added in dolomite in which cases the relationship is reversed. This observation depends for its significance on the differences in the effects of the two salts with and without added magnesia, as otherwise any differences could be ascribed to the effect of sulphur deficiency as well as to differences in the solvent action of the anion.

A Study of Plant Responses to Some Ammonia: Calcium Ratios in Fertilizers. This work was based on the observation of apparent injury to cotton seedlings, following the use of concentrated fertilizers on sandy soils. The injurious component was found to be free ammonia resulting from the dissociation of diammonium phosphate used as a source of phosphoric acid.

This injury could be controlled by admixtures of calcium salts. Magnesium salts were less effective.

It appeared that the efficiency of the calcium salt in this respect was due largely to the neutralization of the free ammonia in the presence of the CO_2 of the soil.

This hypothesis could not be studied directly in the complete fertilizer mixtures so an investigation was made of the possibility of injurious concentrations of free ammonia being formed by the ammonification of organic nitrogen in cottonseed meal, and the effectiveness of gypsum for controlling injury and neutralizing free ammonia. The effect of gypsum on the total

FIG. 2. AMMONIFICATION OF COTTON SEED MEAL

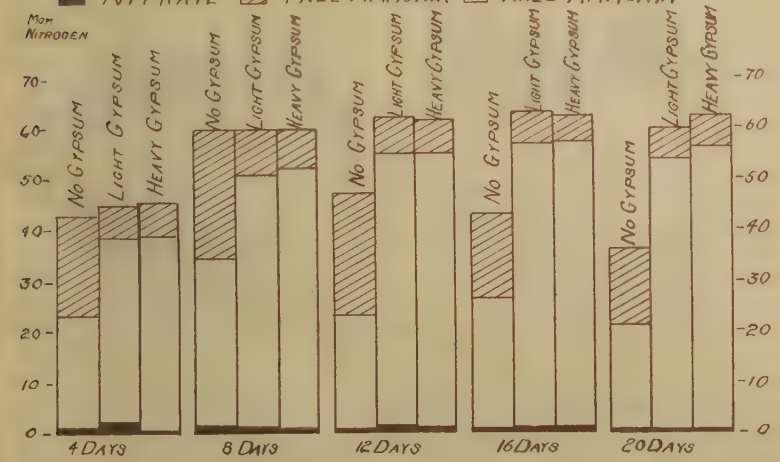
16 LBS NITROGEN PER ACRE

NITRATE ▨ FREE AMMONIA □ FIXED AMMONIA

FIG. 3 AMMONIFICATION OF COTTON SEED MEAL

32 LBS NITROGEN PER ACRE

NITRATE ▨ FREE AMMONIA □ FIXED AMMONIA



and free ammonia in these cultures is shown in Figures 2 and 3. Injury to plants was almost exactly parallel to the concentration of free ammonia.

Factors Influencing the Productivity of Muck Soils. This project has been studied with some amplification of the original plan.

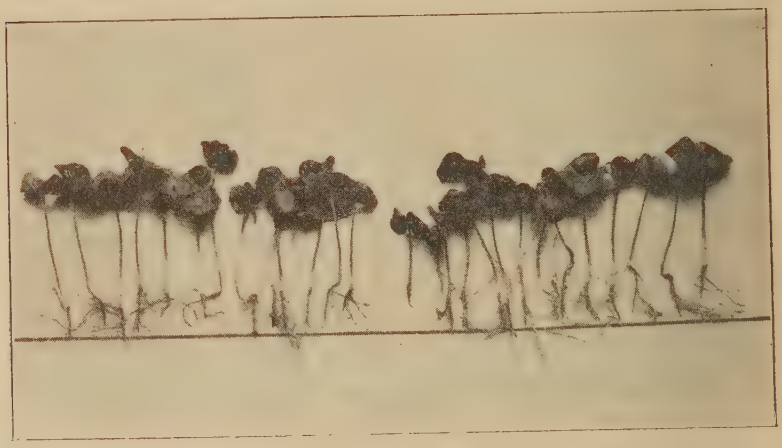


Fig. 4.—Root injury to cotton seedlings from the use of concentrated fertilizer.

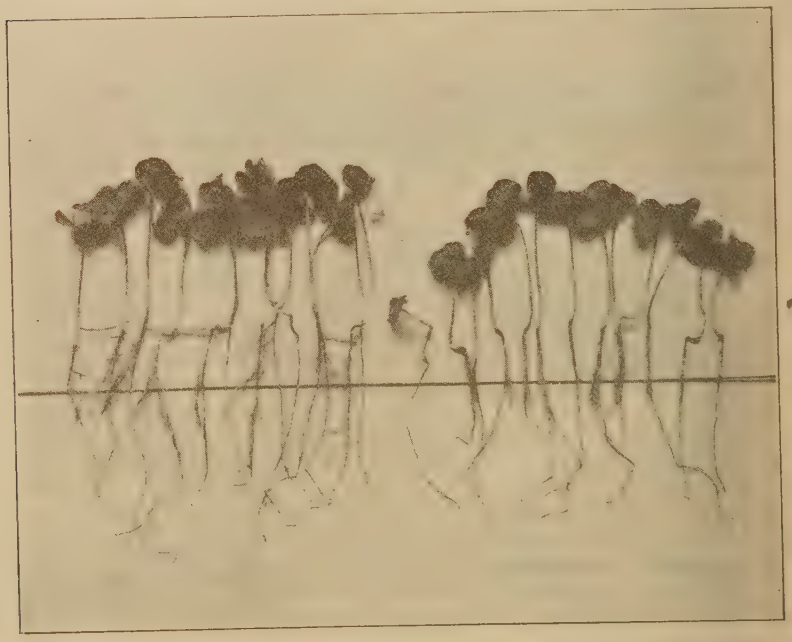


Fig. 5.—Normal root-system development of cotton seedlings with the additional of concentrated fertilizer and gypsum.

The work with copper and manganese shows a distinct response to applications of six tons of lime broadcast and copper sulphate at 50 pounds per acre in the drill. Manganese was of doubtful value.

In the unlimed soil, copper appears to be slightly toxic, with 2 tons of lime it is without effect while with the 6 ton rate of liming, copper is decidedly beneficial although with lime alone the yield at the 6 ton rate was inferior to that with 2 tons.

Fig. 6.—Value of gypsum on Norfolk sand. Ten typical plants shown from field plats representing effect upon growth of each treatment.
(4) Concentrated fertilizer alone.
(5) Concentrated fertilizer with 10 per cent gypsum.
(6) Concentrated fertilizer with 20 per cent gypsum.

From the appearance of the plants it seems that the results of the current year will be in accord with those given above, but with greatly increased yields for all treatments.

The use of superphosphate on these soils has decreased the yield of corn and soybeans. A preliminary test of the effect of the gypsum content of the superphosphate has been started using mono-ammonium phosphate as a source of phosphoric acid. Symptoms typical of superphosphate injury have appeared on the plat with the gypsum treatment while the plants grown on the gypsum free fertilizer are normal.

RESULTS OF SOIL FERTILITY INVESTIGATIONS

AT COASTAL PLAIN BRANCH STATION

Soil Fertility Experiment (Norfolk fine sandy loam). This experiment was started in 1915 to determine the plant nutrient requirements of crops

grown in a three-year rotation on this type of soil. The rotation followed is, corn; oats-and-vetch (for hay), soybeans (for soil improvement), rye (for soil improvement); and soybeans (for seed), rye (for soil improvement). The crops, grown for soil improvement, are not fertilized. To the others nitrogen, phosphoric acid and potash are applied as nitrate of soda, superphosphate and manure salt in varying amounts and ratios. The fertilizer treatments are made in duplicate series, one of which has received a broadcast application of ground dolomitic limestone every three years since 1917.

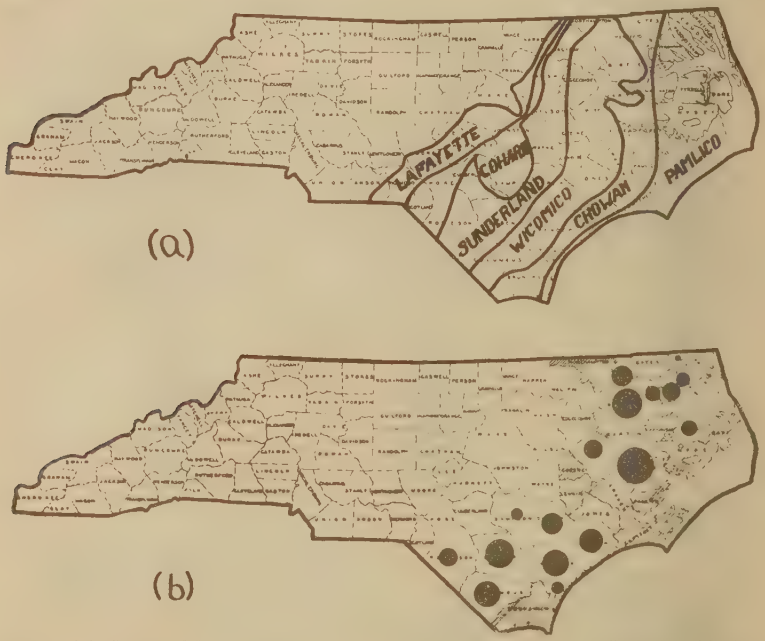


Fig. 7.—(a) Geological Terraces of the Atlantic Coastal Plain in North Carolina. (b) Area and distribution of soil types subject to manganese deficiency. Shaded areas are unsurveyed counties.

Corn, oats-and-vetch and soybeans have responded best to fertilizer containing nitrogen, phosphoric acid and potash. For corn, the addition of nitrogen has been found to be most important for this soil. The response to increased increments of this nutrient has been greater on the unlimed than on the limed series. This is undoubtedly due to the fact that a greater growth of cover crops had been made and turned under on the latter series. An average of the results throughout the duration of the experiment, indicates that an application of about 400 pounds per acre of a fertilizer mixture, analyzing about 6 per cent phosphoric acid, 2 per cent nitgrogen and 4 per cent potash is the most economical proportion for oats-and-vetch for hay, Increasing single nutrients in this complete mixture did not seem to materially increase the yield, however, larger yields were obtained with increasing rates of application per acre of the complete mixture.

Soybeans have responded best to complete fertilizer mixtures containing relatively high percentages of potash and low nitrogen.

The yields of corn and soybeans have been decidedly larger on the limed than on the unlimed series of the experiment. The use of lime has not increased the yield of oats-and-vetch but it has affected the proportion of the two crops in the hay produced. That from the unlimed series has consisted largely of oats, while that from the limed series was primarily made up of vetch.

Although the yields of corn were greater on the limed than on the unlimed series, the amount of corn-root rot was much greater on the limed end.

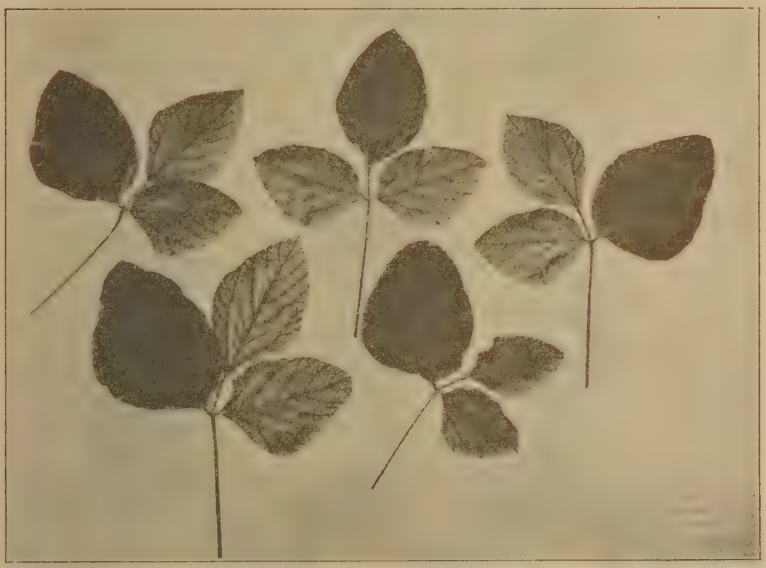


Fig. 8.—Showing five leaves from manganese-deficient soybean plants from the soil type experiment at the Coastal Plain Branch Station farm. The larger and darker leaflet of each leaf was simply dipped in a 1/1000 solution of manganese sulphate which resulted in a rapid correction of the chlorotic condition of the treated leaflets.

When measured by the number of affected stalks broken over, the amount of this disease on the unlimed series varied from 0 to 15 per cent, while on the limed series it ran as high as 75 per cent on some of the plats.

The severity of this disease also varied indirectly with the amount of potash contained in the fertilizer mixtures applied. The limed plat, receiving no potash, had 75 per cent of the stalks broken over, but with the use of 6 per cent potash in the mixture, the infection was reduced to ten per cent.

All the legumes grown on the limed series of this experiment have shown a chlorotic condition of the apical leaves at some stage during the growth of the crop. The severity of this condition varied somewhat with the fertilizer treatment, but it has not as yet apparently affected their yields. This

chlorosis has been shown to be due to manganese deficiency and is closely associated with heavy applications of lime.

Soil Type Experiment (Dunbar fine sandy loam). In this experiment, a three-year rotation of corn; oats-and-vetch, soybeans (for soil improvement) and rye (for soil improvement); and soybeans (for seed) and rye (for soil improvement) is being followed.

Each crop in the rotation to be harvested receives annually the same amounts of nitrogen, phosphoric acid and potash as would be removed by

Fig. 9.—Soybean plants showing typical symptoms of magnesium, potassium and manganese deficiencies.
(1) Magnesium deficiency appears as a chlorosis of the basal leaves and is aggravated by heavy applications of calcitic lime.
(2) Potash deficiency is characteried by marginal chlorosis of the leaves and a tendency of the leaves to cup.
(3) Manganese deficiency causes a chlorosis of the apical leaves and results from neutralization of the acidity of manganese-deficient soils.

normal crops. These constituents are also applied singly and in double and triple combinations of the other constituents. The fertilizer treatments are run in duplicate, one series receiving 2,000 pounds of ground dolomitic limestone broadcast every three years, the other being left unlimed.

The results from this experiment clearly show the necessity of a complete fertilizer for corn, oats-and-vetch, and soybeans grown on this type of soil. The use of lime, in the quantity applied, has not proven profitable for the

crops. Corn, grown on the limed series, has been badly affected with root-rot, the crop on plats receiving potash, however, showing partial immunity. Only a very small percentage of the oats seeded with vetch survive on the limed series, the hay on this consisting almost entirely of vetch. A chlorotic condition of the apical leaves of soybeans grown on the limed series has been found. This condition occurred on all the plats except the one which received phosphate in the form of Duplex basic slag, on which the plants had a normal green color in both series. Since this plat had received considerable amounts of iron and manganese in the basic slag which the other plats did not get and was the only one not chlorotic, it would seem that the chlorosis was probably due to a deficiency of one of these elements. Soil samples were taken from one of the unfertilized and unlimed plats for pot culture work and from the results of this work it was shown conclusively that the chlorosis was due to a deficiency of manganese caused by excessive liming. (See Soil Science, Vol. 30, No. 2, pp. 117-141, 1930.)

AT UPPER COASTAL PLAIN BRANCH STATION

Nitrate of Soda—Sulphate of Ammonia Experiment with Cotton (Norfolk sandy loam). This experiment was designed to compare the efficiency of nitrate of soda and sulphate of ammonia when used singly and in various proportions with each other as sources of nitrogen in a 8-6-4 fertilizer mixture for cotton. An average of the results of two years indicate that there is very little difference in the efficiency of these two sources in supplying nitrogen in a complete fertilizer on this type of soil. Deriving part of the nitrogen from each source gave slightly larger yields than when either material was used as the sole source of nitrogen.

Concentrated Fertilizer Experiment (Norfolk sandy loam). Indications from the work of two years with these materials are that they are no more toxic to young cotton seedlings grown on this type of soil than are ordinary commercial fertilizer mixtures. Based on increased yields per acre, the concentrated fertilizer mixtures are as effective as the less concentrated mixtures made from superphosphate, manure salt and nitrogen derived from nitrate of soda and sulphate of ammonia.

Fertilizer Ratio and Quantity Experiment (Norfolk sandy loam). This experiment has been run continuously in cotton from 1923 to 1928, at which time it was revised to include peanuts in a rotation of cotton and peanuts. Its object is to determine the effect upon stand, growth, maturity and yield of cotton and peanuts of applications of different quantities and proportions of phosphoric acid, nitrogen and potash on a fertile field.

Varying the percentage of phosphoric acid from 6 to 12 per cent, the nitrogen from 3 to 7 per cent, and the potash from 2 to 6 per cent in a complete mixture has had little effect upon the average yield of cotton.

The results of one year with peanuts have not shown any material increase from the use of any fertilizer mixtures being tried out.

Old Rotation Experiment (Norfolk sandy loam). This field consisting of two series, one limed and the other unlimed, has been run in one, two and three-year rotations with and without legumes since 1910. The two-year rotation with legumes was better than continuous cropping of either cotton

or corn. The greatest increased yields, however, were secured with a three-year rotation with legumes and a complete fertilizer.

Some of the results from this field have been published in N. C. Station Bulletin No. 255, issued in 1928.

New Rotation Experiment (Norfolk sandy loam). There are thirteen different rotations run in duplicate series in this experiment which was started in 1924. On the north series, the crops are being fertilized with those mixtures previously found best by the Department for each crop; while on the south series, the crops are fertilized so that at the end of any rotation all plats will have received additions of the same amounts of nitrogen, phosphoric acid and potash. A study of the value of one-, two- three- and four-year rotations, with and without legumes, is being made. To date, of all the crops in the rotations, corn and peanuts have responded most in increased yields to the rotations. In the following table is given the 1929 yield of corn, following six different rotations:

Rotation	Number of Years of Rotation	Crops	Yield—Corn Per Acre—Bushels
1	Continuous	Corn	30.6
2	Continuous	Corn, with crimson clover and rye	32.2
3	2 Years	Corn Cotton	34.2
4	2 Years	Corn, with crimson clover and rye; Cotton, with crimson clover and rye	37.8
5	3 Years	Peanuts, followed by crimson clover and rye; Corn with cowpeas	51.9
6	4 Years	Corn, with cowpeas; Rye (for seed); Soybeans (for seed); Cotton, oats-and-vetch; Oats-and-vetch, soybeans (for soil improvement)	56.7

Study of Sources of Nitrogen (Norfolk sandy loam). This experiment was started in 1925 to compare the relative efficiency of inorganic and organic nitrogen carriers when each was used as the sole source of nitrogen in a complete fertilizer. All fertilizer treatments are made in duplicate, one series being limed and the other unlimed. Results of this experiment are reported in the N. C. Agricultural Experiment Station Report for 1929. The results for this year were very similar to those previously recorded.

Time and Method of Fertilizer Application (Norfolk sandy loam). The object of this experiment, started in 1928, is to determine the effect of different times and methods of applying the fertilizer upon the stand, growth and yield of cotton. Duplicates of each treatment are made, and both series were fertilized with 1,000 pounds per acre of an 8-4-4 fertilizer mixture. In series 1, all the nitrogen is derived from nitrate of soda, and in series 2, it is derived equally from nitrate of soda, sulphate of ammonia and cotton-seed meal. Superphosphate and muriate of potash were used as sources of phosphoric acide and potash in both series.

The injury to the young seedlings was greater on series 1 than series 2. Applying the fertilizer 10 days before planting gave better control of the

fertilizer injury in 1929 than did any other method being tried. This season, however, the amount of injury on both series was very light.

General Fertilizer Experiment with a Rotation of Corn and Soybeans (Okenee fine sandy loam). This experiment was started in 1926 to determine the best fertilizer for corn, soybeans (for seed), and soybeans (for hay), and to show the effect upon the succeeding crop of corn of picking soybeans for seed (remaining parts being turned back for soil improvement) versus cutting them for hay.

The resulting differences in yield of corn fertilized in different ways, following two methods of harvesting soybeans are very marked as shown by the results for two years given below.

Fertilizer		Yield in Bushels of Corn Per Acre Following			
		1927		1929	
Pounds Per Acre	Formula	Soybeans Picked	Soybeans Cut for Hay	Soybeans Picked	Soybeans Cut for Hay
600	6-6-0	49.7	31.0	54.4	28.6
600	0-6-4	54.9	46.7	63.1	43.6
600	6-0-4	27.7	26.2	34.2	16.4
600	6-6-4	52.8	40.5	60.6	43.3
600	6-6-4-L	44.1	41.5	58.3	42.2
No Fert.	0-0-0	26.9	19.2	29.1	12.5
Average Yield Per Acre		42.7	34.2	50 0	31.1

From these results, it is evident that the difference in the fertility of the two series in favor of the one on which the soybeans are picked is becoming greater each year. The percentage increase in yield of corn on the soybean-picked series was 25 per cent in 1927 and 61 per cent in 1929 greater than on the series in which the soybeans were cut and removed for hay.

Fertilizer and Dusting Experiment with Peanuts (Norfolk sandy loam). The object of this experiment is to determine the influence of fertilizers and certain dusts and sprays upon growth, maturity, quality and yield of peanuts grown in rotation with cotton. There are two sections of the field consisting of 40 plats each. Cotton and peanuts are rotated on the two sections which are divided into two series of 20 plats each. When in peanuts, series 1 is fertilized uniformly with 400 pounds per acre of an 8-2-4 mixture, while series 2 is left unfertilized. There are eight special treatments and two checks, so in each series the treatments are duplicated, which gives quadruplicate plats of the special treatments as follows:

(1) Limestone—400 lbs. per acre in the drill at planting time.
(2) Gypsum—400 lbs. per acre in the drill at planting time.
(3) Check—No special treatment.
(4) Limestone—400 lbs. per acre in the drill at planting time.
Gypsum—400 lbs. per acre on ground, not on foliage, at blooming time.

(5) Limestone—400 lbs. per acre in the drill at planting time,
Gypsum—400 lbs. per acre on the foliage at blooming time.
(6) Gypsum—400 lbs. per acre on foliage at blooming time.
(7) Sulphur—94 lbs. per acre on foliage at blooming time.
(8) Check—no special treatment.
(9) Bordeaux—100 gals. on foliage at blooming time.
(10) $BaCO_3$—50 lbs. on foliage at blooming time.

The section in cotton each year is fertilized uniformly in the drill at planting with 800 pounds per acre of a 10-4-4 mixture.

The shedding of nuts per acre was determined by picking up the peanuts on each plat after digging. Although there was more shedding on the

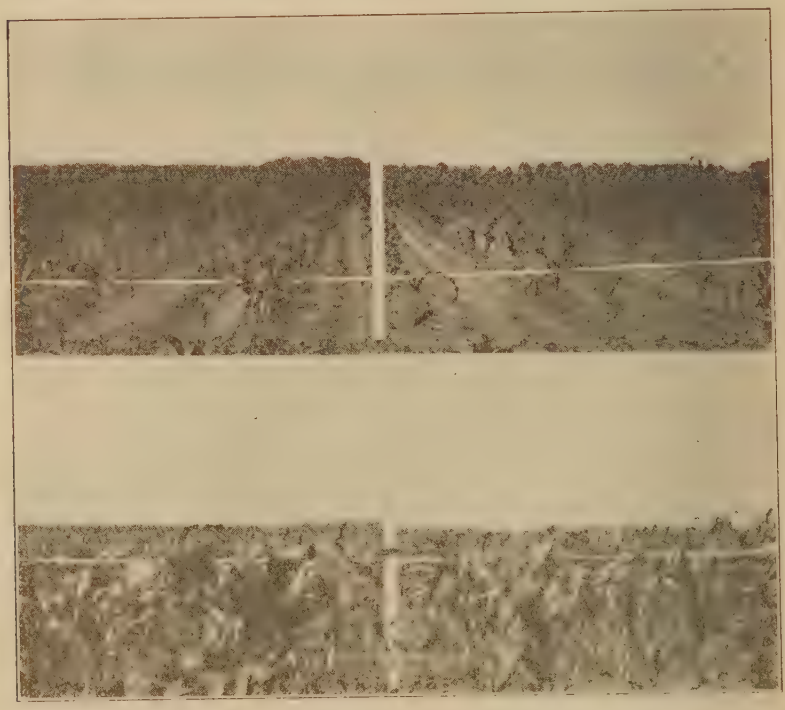


Fig. 10.—Showing effect of methods of handling previous crops of soybeans upon the growth of a crop of corn following, both crops being unfertilized.
(Upper view) Two previous crops of soybeans cut and removed for hay.
(Lower view) Two previous crops of soybeans picked for beans and other parts of the plants turned into the soil. (Corn photographed June 21, 1930 at Upper Coastal Plain Branch Station.)

fertilized series, there was only a small difference in the percentage of shedding on the two series. The special treatments had very little effect upon the amount of the shedding.

Leaf spot was decidedly more prevalent on the unfertilized series. These plants never appeared as thrifty as those receiving fertilizer treatments.

The grade and class of the nuts produced was determined according to the U. S. Standard Grades and showed that the fertilizers applied helped to improve the grade of unshelled peanuts but the class, as determined by shelled nuts, was better on the unfertilized series.

It is impossible to draw any definite conclusions from the results of the one year as to the effects of the special treatments.

Utilization of Crops (Norfolk sandy loam). This experiment, being conducted in coöperation with the Department of Animal Husbandry of this Station, was designed to compare crop yields, financial returns and effects upon fertility of the soil of following two methods of utilization of crops. A three-year rotation of corn and soybeans; cotton, with crimson clover and rye; soybeans followed by crimson clover and rye, is being followed. By the first method all crops are hogged-off except cotton, while by the second method certain crops are harvested, while others are turned under for soil improvement.

Field No.	Utilization of Crops	1927 Corn Per Acre Bushels	1928 Seed Cotton Per Acre Pounds	1929 Soybean Hay Per Acre Pounds
1	NPK—Harvested for Grain	22.0	562	2560
2	NPK—Hogged off	24.5*	565	Hogged off
3	NPK—Hogged off, 80 per cent of fertilizing value of feed deducted from NPK before adding	23 2*	456	Hogged off

*Yields estimated by harvesting a fraction of each acre as plats were hogged off.

AT BLACKLAND BRANCH STATION (MUCK)

General Fertilizer Experiment. This experiment was designed to determine the value of commercial fertilizers used in varying amounts and proportions, and to compare the efficiency of various phosphate carriers used on crops on this type of soil. A three-year rotation of corn; oats, soybeans for soil improvement; and Irish potatoes is being followed. There are three series of plats in the experiment so that each crop is grown every year.

Phosphoric acide in the form of either Duplex basic slag, rock phosphate or superphosphate in a complete fertilizer has not materially increased the yields of any of the crops. Potash is the most essential constituent for the production of crops on these soils as shown by the average results for seven years given below.

Fertilizer Treatment	Corn Per Acre Bushels	Oat-and-Vetch Hay Per Acre—Pounds	Irish Potatoes Per Acre—Bushels
None	17.3	2,985	69.5
NP	14.8	3,281	72.7
NK	44.8	4,721	141.2
NPK	36.4	5,263	173.0

Corn grown on the plats, not receiving potash, was infected practically 100 per cent with root-rot. On plats fertilized with potash, it was not nearly so severe. The addition of nitrogen or phosphoric acid has not been found to materially increase the yields of any of the crops over no fertilizer treatment.

Lime Experiment. This experiment was begun in 1917 to compare the relative efficiency of hydrated lime, marl and ground limestone when applied at the rate of one, two, three and four tons per acre of calcium carbonate equivalents. A report of the efficiency of these materials is given in the 1929 Annual Report of the N. C. Experiment Station and shows them to rank as follows in order of efficiency: ground limestone, hydrated lime, and marl.

The use of 300 pounds per acre of an 8-2-4 fertilizer has increased the yields of corn when used with one, two, three and four tons per acre of ground limestone. However, when used without lime the yields have been decreased.

Cultural Treatment of Corn and Soybeans. This field is divided into two series, each of which is rotated in corn and soybeans. There are eight one-fifth acre plats in each series, prepared each year as follows:

(1) Plowed 8" deep, level, not rolled.
(2) Plowed 8" deep, level, rolled.
(3) Disked 4" deep, level, rolled.
(4) Disked 4" deep, level, not rolled.
(5) Plowed 8" deep, ridged, not rolled.
(6) Plowed 8" deep, ridged, rolled.
(7) Disked 4" deep, ridged, rolled.
(8) Disked 4" deep, ridged, not rolled.

The results obtained in this experiment in 1929 were practically reversals of those secured during the previous three years. The 1929 season was extremely wet and the corn cultivated on a ridge produced an average yield of 36.3 bushels per acre against 19.8 bushels per acre where the corn was cultivated flat. When these results are averaged with those of previous years, however, the flat cultivation is slightly better.

This work indicates that no increased yields of corn can be expected from rolling this soil before planting. Plowing eight inches deep versus disking 4 inches has shown deep plowing to be neither injurious nor very beneficial.

General Fertilizer Experiment—Rotation of Corn and Soybeans. A two-year rotation of corn and soybeans is being followed in this experiment, which was started in 1928. There are two series of 26 plats each. Nitrogen, phosphoric acid and potash are supplied by nitrate of soda, superphosphate and manure salt, singly and in several double and triple combinations to determine the best fertilizer mixture each for corn and soybeans.

When in soybeans, the south series is cut for hay while the north series is picked for seed, the remaining parts of the legume being turned back into the soil for its improvement. The results of one year with corn, following these methods of harvesting soybeans, indicate that there will not be the great difference in yields of corn on the two series as has been the case at the Upper Coastal Plain farm. This year, the average yield of corn follow-

ing soybeans cut for hay was greater than when they were picked for seed.

Potash, when used alone or in combination with nitrogen or phosphoric acid, materially increased the yield of corn. Nitrogen and phosphoric acid with potash were ineffective.

AT MOUNTAIN BRANCH STATION

Soil Fertility Experiments with Corn (Toxaway loam). On Field A in 1929, in a three-year rotation of corn, wheat and soybeans, the best yield was obtained with a 7-3-3 mixture, using 400 pounds in the drill per acre. The plat limed every three years at the rate of one ton of ground limestone per acre gave an increase of 16.8 bushels over the corresponding unlimed plat. Omitting phosphoric acid from the fertilizer mixture resulted in a greater decrease in yield than did omission of either nitrogen or potash. Absence of potash caused least decrease in yield. Profitable increases in yields were obtained by increasing rates of application up to 800 pounds per acre.

With Irish Potatoes (Toxaway loam). In this experiment on Field B on which Irish potatoes are grown in rotation with wheat and soybeans for hay, the following have been some of the essential findings as an average of the results of the past five years:

(1) In comparing sulphate of potash, muriate of potash and kainit, each as sole sources of potash, in 800 pounds per acre of an 8-4-6 fertilizer mixture, muriate of potash has shown to be the best carrier of potash. The average yields have been 113.4 bushels for muriate; 109.6 bushels for sulphate; and 98.8 bushels for kainit.

(2) The use of dolomitic limestone at the rate of 2,000 pounds per acre broadcast every three years reduced the quality and yield per acre, 11.5 bushels without fertilizer and 13.7 bushels per acre with 800 pounds of an 8-4-6 mixture. The potatoes on all plats receiving an application of limestone were badly affected by scab.

(3) In a comparison of 400, 800 and 1,600 pounds of an 8-4-6 mixture per acre in the drill at planting, the average yields were:

(a) For 400 lbs.— 89.9 bus. per acre.
(b) For 800 lbs.—109.6 bus. per acre.
(c) For 1,600 lbs.—115.6 bus. per acre.

These results indicate that for average market conditions, the use of about 800 pounds per acre will be the most profitable quantity to use on this type of soil in the mountains.

(4) The use of a complete fertilizer has given much more profitable yields than has the use of any single or any combination of two plant nutrients. Results have indicated that of the singles, ammonia and phosphoric acid appear to be much more deficient in this soil than is potash. The use of 800 pounds of an 8-4-6 per acre has given on an average of 2.86 times the yield secured where no fertilizer was used.

With Soybeans (Toxaway loam). In this experiment, the following are some of the practical results thus far secured:

(1) In a comparison of three sources of potash used in 400 pounds per acre of a 12-2-4 fertilizer mixture, kainit proved decidedly most efficient, with an average yield of 5,710 pounds per acre of dry hay. Muriate of potash was second best with a yield of 4,798 pounds, and sulphate of potash least satisfactory with a yield of 4,535 pounds.

(2) In using dolomitic limestone at the rate of 2,000 pounds broadcast every three years, its use alone more than doubled the yield, increasing it by 2,875 pounds per acre. Used with complete fertilizer, its use gave an increase in yield of 2,345 pounds per acre over complete fertilizer used alone.

(3) In comparing the relative value of the use of 200, 400 and 800 pounds of a 12-2-4 mixture per acre in the drill at planting, the yields were increased as the application increased, but the most profitable application has been found to be about 400 pounds per acre.

(4) In using single constituent alone, the responses were best for phosphoric acid.

(5) The use of a complete fertilizer has given larger yields than has the use of any singles or doubles. Used at the rate of 400 pounds per acre, with the potash derived from kainit, it has more than doubled the yield of dry hay, the increased yield being 2,695 pounds of dry hay per acre.

With Wheat (Toxaway loam). With this crop, grown in rotation with Irish potatoes and soybeans for hay, the following results have been secured as an average of four years' results:

(1) There has been found to be very little difference in the value of sulphate of potash, muriate of potash and kainit as sources of potash in a complete mixture, the difference being slightly in favor of muriate and kainit.

(2) Dolomitic limestone, used broadcast at the rate of 2,000 pounds per acre every three years, has more than doubled the yield of wheat where no fertilizer was used; but when used with complete fertilizer its use only increased the yield 2.8 bushels per acre over what was secured by fertilizer used alone.

(3) In using complete fertilizer analyzing 7-3-1½, used at the rates of 200, 400 and 800 pounds per acre at seeding time, the most profitable returns were secured from the 400-pound application.

(4) A complete fertilizer has been found to be more profitable than either single or double constituent applications.

Relative Value of Several Sources of Phosphoric Acid (Toxaway loam). In this experiment conducted on Field G, red clover was the crop for 1929 in a three-year rotation of corn, wheat, and red clover. Red clover died out badly in the spring and soybeans were substituted as the legume. Superphosphate, rock phosphate, soft phosphate and Duplex basic slag were used as the sources of phosphoric acid for comparison. Results thus far secured with soybeans were in line with those of previous years, both with corn and wheat. Superphosphate proved the best source; Duplex basic slag, second; soft phosphate, third; and rock phosphate, fourth as shown below.

Fertilizer Treatment Per Acre	Source of Phosphoric Acid	Soybean Hay Per Acre—Pounds
400 lbs. 8-1-4	Superphosphate	4,613
400 lbs. 8-1-4	Duplex basic slag	4,402
400 lbs. 8-1-4	Soft Phosphate	4,245
400 lbs. 8-1-4	Rock phosphate	4,063

These plats are arranged in three series with the same fertilizer treatment for each series. One series is limed every three years at the rate of one ton of ground limestone per acre. In 1929, the limed series gave an increased yield of 1,557 pounds of soybean hay over the corresponding unlimed series of plats. A third series has all the nitrogen derived from stable manure. This latter series has given an increased yield of 1,551 pounds of hay over the comparable series having nitrate of soda as the source of nitrogen.

Soil Type Studies (Toxaway loam). These field studies consist of experiments in a four-year rotation of corn, oats, wheat and soybeans. Fertilizers are applied in amounts equal to the plant constituents removed by maximum crops. On a portion of the plats, the nitrogen is supplied by crimson clover grown as a winter cover crop and turned under. The phosphoric acid is supplied from two sources for comparison—superphosphate and rock phosphate. Results with soybeans for hay in 1929 showed greater yields from the use of rock phosphate where double the amount of phosphoric acid was used. The corn yields of 1929 showed a slight increase from the use of rock phosphate, but averages over a seventeen-year period have shown the superiority of superphosphate as a carrier of phosphoric acid on this soil.

AT PIEDMONT BRANCH STATION (CECIL CLAY LOAM)

Soil Fertility Work. This work is being conducted to show the chief plant food needs of the Cecil soil series; to find the best proportions of the fertilizing constitutents for crops adapted to the Piedmont region; and to study the effects of deficiencies upon the growth and yield of crops. Three separate fields are used in the study and the rotation was so started that three of the four crops of the rotation in the rotation system appear on the three fields every year. The four-year crop rotation used in this experiment is as follows:

1st year—Cotton, rye (cover crop).
2nd year—Corn, wheat (in fall).
3rd year—Wheat, red clover.
4th year—Red clover.

One-half of all plats are limed broadcast with one ton of ground limestone applied every fourth year. Cotton, wheat and red clover occupied the fields in 1929. Results secured were, in the main, in harmony with those of previous years. When only one plant nutrient was applied, phosphoric acid gave the highest yield, with nitrogen second in importance. Potash gave least response

in yields, but proved quite efficient in aiding in controlling nutritional troubles. Cotton, following clover, was badly affected with rust, especially on the limed series of the plats. A high potash percentage in the fertilizer—5 to 7½ per cent—prevented the rust, while a high percentage of phosphoric acid seemed to augment it, particularly on the limed series of the field.

The addition of lime, phosphoric acid, and potash was necessary for the successful growth of red clover. On the unlimed series of the plats, red clover failed except for those plats which received liberal applications of phosphoric acid and potash. On the limed series, applications of phosphoric acid alone gave greater yields of red clover hay than did applications of either nitrogen or potash alone.

Superphosphate vs. Rock Phosphate. In this study of the comparative value of two phosphoric acid carriers, the results with red clover for the past year continued to show that superphosphate is a more efficient carrier of phosphoric acid than is rock phosphate, when both are used in quantities carrying equal amounts of phosphoric acid.

Nitrogen Carriers. This experiment is designed to compare the relative value of the more common sources of nitrogen when used in a complete fertilizer for corn and cotton. A two-year rotation of cotton and corn is used. Results with corn in 1929 show a ranking for the year as follows: nitrate of ammonia, sludge, urea, cottonseed meal, nitrate of soda, calcium cyanamid, leuna-salpeter, and sulphate of ammonia in the order given. Nitrate of ammonia has led with corn for the past two years.

Crop Rotation. The crop rotation work consists of a field study of the value of one-, two- and three-year rotations, with and without legumes (cowpeas, soybeans, and red clover), the fertilizer crop-applications being the same for each crop as it appears in the rotations. One-half of all plats are limed every fourth year with one ton of ground limestone broadcast per acre. On the unlimed half in 1929, continuous cropping of wheat gave an increased yield of 8.7 per cent over a two-year rotation of corn and wheat, without a legume; while the two-year rotation with a legume gave an increased yield of 18 per cent over continuous cropping. Wheat, in the three-year rotation of wheat, red clover, and corn, gave an increased yield of 32.6 per cent over continuous cropping of this crop; and an increased yield of 12.3 per cent over the two-year rotation, with a legume. For the limed half of the field, continuous cropping of wheat gave an increased yield of 64.1 per cent over the two-year rotation, without a legume; and an increased yield of 8.6 per cent over the two-year rotation, with a legume. The three-year rotation gave an increased yield of 22.6 per cent over continuous cropping of wheat; and an increased yield of 33.1 per cent over a two-year rotation with a legume. Comparative results for continuous cropping and the two-year rotations on both the limed and unlimed halves are for this year at variance with the averages of past years.

AT CENTRAL STATION (CECIL CLAY AND SANDY LOAM)

Best Proportion of Organic to Inorganic Nitrogen for Cotton. Three sources of inorganic nitrogen—nitrate of soda, sulphate of ammonia and leuna-salpeter—are being used in this study of the value of varying propor-

tions with cottonseed meal as the organic source for cotton. In 1929, a proportion of 65 per cent nitrogen from nitrate of soda and 35 per cent from cottonseed meal gave the highest yield of seed cotton per acre. In the sulphate of ammonia series, a proportion of 80 per cent nitrogen from sulphate of ammonia and 20 per cent from cottonseed meal gave the largest yield. In the leuna-salpeter series, a ratio of 80 per cent nitrogen from leuna-salpeter to 20 per cent from cottonseed meal gave best yield.

Sources of Lime. In a comparative study of the value of burnt lime, hydrated lime and ground limestone, applied every fourth year at rates equivalent to one, two and four tons of calcium corbonate per acre, soybeans for seed; rye, corn; oats-and-vetch (for hay), soybeans for seed; cotton and crimson clover (for hay) are grown in a four-year rotation on the plats, with soybean vines and rye used for soil improvement. All plats are fertilized with equal amounts of phosphoric acid from 16 per cent superphosphate. No nitrogen and potash are used.

Yields with soybeans for seed in 1929 were highest from an unlimed check plat. The second highest yield was obtained from the use of two tons of burnt lime per acre. Yields from one ton of ground limestone ranked third. The one-ton rate per acre proved most efficient for hydrated lime and ground limestone, while the two-ton rate was most efficient for burnt lime. The four-ton rate of application gave the lowest yields in all cases. The soybeans showed much evidence of potash deficiency, especially on the heavily limed plats.

COOPERATIVE TOBACCO INVESTIGATIONS

All the research work noted below is being conducted in coöperation with the Office of Tobacco Investigations of the U. S. Department of Agriculture. The research investigations with this crop were started on Durham sandy loam at the Tobacco Branch Station at Oxford in 1911; on Norfolk sandy loam on the Upper Coastal Plain Branch Station near Rocky Mount in 1927; and on Porter's loam, near Swannanoa, on the Mountain Branch Station in 1930. The work being conducted at the Tobacco and Upper Coastal Plain Branch Station farms is with flue-cured bright, and that located at the Mountain farm is with burley tobacco.

The work at Oxford consists of something over 400 plats, on which different fertilizer materials and various combinations of these materials are tested including C. P. materials. The effect of chlorine, sulphur, calcium and magnesia on tobacco is being studied. More detailed studies of nitrate of soda and cottonseed meal with relation to the time of application and the rate of absorption are being carried on at this farm. Other work consists of crop rotation, effect of different crops including the legumes on tobacco, potash and nitrogen tests.

The work at the Upper Coastal Plain Station, near Rocky Mount, in Edgecombe County consists of over 200 plats on which fertilizer tests, crop rotation and varieties are being studied.

At the Mountain Station, located in Buncombe County, some simple fertilizer and variety tests are being made with burley tobacco. Black root rot (Thielavia basicola) is common on soils that grow burley tobacco and for that reason resistant strains were used. The first year's indications

show that magnesia will give additional yield and quality, also that phosphoric acid is very essential to be added for best paying yields.

Some progress has been made each year. At the same time new problems are continually coming up which need the attention of investigators. All phases of the tobacco work are studied, but up to the present more has been done on the nutritional and variety problems than on others. During the past three seasons, special emphasis has been placed on the study of diseases which are becoming more numerous each year. The plant pathologist has given his entire time to the study of the tobacco disease problems for the past three summers. Special work with mosaic has been done. Beginning with the season of 1930 a two-acre field which was badly infested with Black root rot (Thielavia basicola) was leased and 87 selections and varieties were planted on this field. Some of these varieties were of the burley type and some of the cigar-binder type, which had proven to be resistant in Kentucky and Wisconsin. These varieties were resistant in the tests made at Oxford, but were not desirable types for flue-cured purposes as was expected. Fortunately, however, two selections of flue-cured tobacco have shown considerable resistance this year. These selections will be subjected to more severe tests next year and if they continue to show resistance, seed for distribution will be available.

Variety Work. This work, which consists of selection and breeding, has been continued. Over 40 selections were tested this year as to their comparative yields and values. A large number of so-called varieties have been tested during the past few years and discarded on account of their low yield value. The results up to the present time indicate that Cash, White Stem Orinoco, Jamaica and Bonanza are the four best varieties for cigarette tobacco. The White Stem Orinoco is the most desirable for thin sandy soils; Cash for heavy and more fertile soils; and Jamaica and Bonanza may be classed as intermediates.

Fertilizer Tests. A large number of plats have been used in making tests with different fertilizer materials and combinations both at the Tobacco and Upper Coastal Plain Stations. Different sources of phosphates, nitrogen and potash have been used. A number of the synthetic nitrogen carriers have been used alone and in combination. Urea has been one of the best in this class, but in practically all cases, a mixture of different materials supplying the nitrogen has given better results than has any individual source. For this reason it is recommended that as much as 50 per cent of the nitrogen for tobacco fertilizers be derived from organic materials of vegetable or animal origin. In practically all tests with potash the more liberal applications have proven to be beneficial.

Curing. Observations have been made relative to the arrangement of the furnaces and pipes in tobacco curing barns, and a number of different types of furnaces have been tested with different arrangements of the pipes. The observations so far show that more uniform heat control may be had by using more pipes or flues in the barn than are now being used. With well constructed barns built of wood or fire-resistant materials such

as concrete blocks or clay tile, and the use of increased pipes well placed in the barn, the fuel consumption as well as the fire hazard may be materially reduced.

FERTILIZER RESULTS FROM OUTLYING SOIL-TYPE FIELDS WITH FARMERS OF THE STATE

With Peanuts on Norfolk and Coxville fine sandy loams (Bertie and Hertford counties). The experiment in Bertie County followed cotton on a rather fertile Norfolk soil, while the one conducted in Hertford County followed corn on a Coxville soil, low in fertility. The results thus far secured seem to show that fertilizers are profitable for peanuts when grown on a poor soil following a crop that has not been heavily fertilized, and that little or no response is secured from their use when the peanuts are grown on very fertile soils. Results indicate that potash is the most essential constituent in the fertilizer for most profitable production of this crop. The use of 300 to 400 pounds per acre of gypsum, applied uniformly on the foliage of the plants at blooming time, has been found to be profitable, especially so in dry seasons. The use of lime only under the crop has resulted in an increase in yield on Coastal Plain soils having a pH of less than 6.0.

On Ashe loam (Burke County). The 1929 results with corn conform closely with the averages for 1927 and 1928. Withholding phosphoric acid from the fertilizer mixture has had more effect in decreasing yields than has the leaving out of the mixture either nitrogen or potash. Absence of potash in the mixture resulted in no material decrease in yield of corn. Increasing the rate of fertilizer application above normal has given a good increase in yield. The beneficial effects of liming two years previously have been shown also in the results secured this year.

On Toxaway loam (Tryansylvania County). On this field, a study is being made to determine the best proportions and amounts of nutrients for the growth of corn and wheat, both when limed and unlimed. Results with corn for 1929 have shown a beneficial effect from the use of lime on this soil, having a pH value of around 5.2. Increasing the percentage of phosphoric acid in a complete fertilizer had most effect in increasing yields, nitrogen ranking next in importance. Varying the potash percentage in the mixture had least effect upon yields. Dividing the application of nitrogen has given a small increase in yield over applying all of it at planting time.

Wheat yields for the past year were strongly affected on this field by the fertilization of the preceding crop, so no reliable deductions can be made from this year's results.

On Appling sandy loam (Davie County). The trend of results with cotton on this type of soil for 1929 are in line with those for 1927 and 1928. Five per cent potash in a complete fertilizer has proved thus far the best percentage in the mixture for this crop. Kainit proved to be a slightly better source of potash in a complete fertilizer in this year's results as is shown below.

Fertilizer Treatment Per Acre	Source of Potash	Yield Seed Cotton Per Acre—Pounds
600 lbs. 10-5-3	Kainit	1,680
600 lbs. 10-5-3	Muriate of potash	1,650
600 lbs. 10-5-3	Trona muriate of potash	1,620
600 lbs. 10-5-3	Manure salts	1,120

Of several sources of nitrogen being tested, calurea showed the highest yield of cotton and superphosphate proved the best source of phosphoric acid in 1929.

Profitable increases in yield of seed cotton were obtained by increasing the rate of application of fertilizers up to 900 pounds per acre.

On Wilkes sandy loam (Guilford County) and Congaree silt loam (Watauga County). The work with Japanese mint was begun in 1928 in coöperation with the Vick Chemical Company of Greensboro, for the purpose of developing a profitable crop adaptable for small mountain areas and to determine the plant nutrient needs of this crop for best growth. Liming has proven beneficial in promoting vegetative growth. The chief deduction to be drawn from the 1929 results is the value of high potash fertilization.

The largest yield of oil was secured on the Guilford field by the use of a 10-7-16 fertilizer mixture and on the Watauga field from 15-6-6 and 10-4-4 mixtures. The highest percentage of menthol in the oil was obtained when a 15-9-6 mixture was used on the Guilford field, and a 10-2-4 mixture on the Watauga field.

SOIL TYPE FERTILITY FIELD EXPERIMENTS IN COOPERATION WITH THE FEDERAL BUREAU OF CHEMISTRY AND SOILS

Time and Method of Fertilizer Application (Norfolk loamy fine sand (Currituck County)). This experiment, with Big Stem Jersey sweet potatoes has been conducted to determine the best means and time of applying fertilizer to this kind of potatoes when grown on light sandy soils. Great difficulty has frequently been experienced in the past by farmers in getting the sprouts to live after using large amounts of fertilizer at or just before transplanting the sprouts. The results secured in this experiment indicate that the difficulty can be largely, if not entirely, overcome by applying the fertilizer after the plants are set and have taken root. Applying one-half of the fertilizer before transplanting and one-half later has been found to eliminate most of the injury. However, when the entire application is made after transplanting, the injury is entirely overcome and the yields are increased thereby.

Fertilizer mixtures made up with low grade potash salts, such as kainit, have been found to be much more injurious than when the potash is derived from muriate of potash. Urea, as a source of nitrogen in a complete fertilizer has not been found to be as injurious to the young plants when applied at transplanting time as was nitrate of soda.

Fertilizer Experiments with Irish Potatoes (Bladen fine sandy loam in Beaufort County). These experiments include a study of the effects upon yield of early Irish potatoes of the following factors:

(1) Of varying quantities per acre in the drill at planting of 7-5-5, 6-7-5 and 7-5-7 mixtures, and of the 7-5-5 used one-half before planting and the other half as a side application after the potatoes had established a stand.

(2) Of varying percentages of potash from 0 to 10 per cent in a 6-7-0 mixture used at the rate of 2,000 pounds per acre in the drill just before planting.

(3) Of each of three common sources of potash (muriate, sulphate and manure salt) in a 6-7-5 mixture.

(4) Of varying percentages of nitrogen in a 6-0-5 mixture.

(5) Of varying sources and proportions of mineral and organic nitrogen in a 6-7-5 mixture, using cottonseed meal as the organic and nitrate of soda and sulphate separately as the inorganic sources.

The following have been the findings under the various phases of this project as a result of work of the past three years:

(1) In a comparison of 1,600, 2,000, and 2,400 pound-applications per acre in the drill 2 to 4 days before planting the largest yields were secured from the use of 2,000 pounds.

(2) A mixture, analyzing 6-7-5, has given slightly larger yields during two out of three years than either a 7-5-5 or a 7-5-7 mixture.

(3) Where the fertilizers were applied one-half before planting and one-half after the potatoes were up, a larger yield was secured in all cases, except one, where the fertilizers were all applied before planting the crop.

(4) Varying the potash from 0 to 10 per cent, derived from muriate of potash, 6 per cent has given best results on this type of soil in a 6-7-0 mixture.

(5) Of the three sources of potash (muriate of potash, manure salt, and sulphate of potash) in 2,000 pounds per acre of a 6-7-5 mixture, muriate of potash has given the largest and manure salt the poorest yield in each of the three years.

(6) Varying the ammonia from 0 to 10 per cent, derived equally from nitrate of soda, sulphate of ammonia and cottonseed meal, the results secured, as a whole, up to this time have shown that the most efficient content of ammonia is 6 to 8 per cent in a 2,000-pound per acre application in the drill at planting of a 6-0-5 mixture.

(7) As sole sources of ammonia in a 2,000-pound application per acre of a 6-7-5 mixture, nitrate of soda and sulphate of ammonia have each given practically the same yields. Urea and ammonium phosphate have, on an average, given larger yields than has either nitrate of soda, leuna-salpeter or sulphate of ammonia.

(8) In a study of various proportions of organic (cottonseed meal) and inorganic nitrogen (nitrate of soda and sulphate of ammonia) in a 2,000-pound drill application of a 6-7-5 mixture, the following results have been secured where the inorganic content varied by increments from 50 to 100 per cent of the total per cent of ammonia in the mixture:

(a) In the nitrate of soda series, the largest yield has been obtained where the ammonia was derived 35 per cent from cottonseed meal, and 65 per cent from nitrate of soda.

(b) In the sulphate of ammonia series, the largest yield was secured where the ammonia was derived 20 per cent from cottonseed meal and 80 per cent from sulphate of ammonia.

Soil-Deficiency Experiment with Soybeans (Bladen fine sandy loam in Currituck County). This experiment was planned and started to determine the effect of commercial fertilizers, lime, and special treatments upon the yield and quality of soybeans when grown on this type of soil on which in previous growth they had shown pronounced malnutrition symptoms.

Fertilizer mixtures, containing relatively high percentages of phosphoric acid and potash, materially increased the yields over the unfertilized plats. The addition of 100 pounds per acre of manganese sulphate to the fertilizer alone gave only slight response for the use of the manganese. Limestone was the most effective material added in increasing both the yield and quality of the beans in this soil. When the sulphate of manganese was used with the limestone, it was decidedly more profitable than when used alone. The largest average yields were obtained, however, when complete fertilizer, limestone and sulphate of manganese were applied together.

Concentrated Fertilizer and Time-of-Application Experiment with Cotton (Norfolk sandy loam in Wayne County). One year's results from this experiment show that concentrated fertilizer mixtures, used at the equivalent rate of 900 pounds per acre of an 8-6-4 mixture, were just as effective in promoting crop yields as was a mixture made up of ordinary commercial materials. Dividing the application of concentrated fertilizer, applying one-half just before planting and one-half after chopping, was not only less injurious to the young cotton seedlings but resulted in the production of larger yields of the crop than when all the concentrated fertilizer was applied before the planting of the crop.

On Cecil clay loam at Central Station. In this experiment, four different fertilizers—two concentrated mixtures and two with equivalent amounts of plant-food from commercial mixtures—were applied to the soil in various ways, both ten days before planting and at planting time. One purpose in this experiment was to study the effects upon germination of cotton seed resulting from the different methods of applying the various mixtures. Results for 1929 have shown an increase of 13.6 per cent in missing hills for the concentrated mixtures over what was secured where commercial mixtures were used. The commercial mixtures have given an average increase in yield of 18.9 per cent over the concentrated mixtures. Applying the fertilizers—both concentrated and commercial—10 days before planting gave 2.5 per cent better stand than did applying them at planting time. An increase of 1.1 per cent in yield was secured by applying all mixtures 10 days before planting over applying them at planting time.

On Cecil clay loam in Franklin County. This experiment was designed to study the best proportion of inorganic and organic nitrogen in complete fertilizers for the production of cotton on this soil type. Nitrate of soda, sulphate of ammonia and Ieuna-salpeter are each used in a separate series

as sources of inorganic nitrogen; and cottonseed meal as the source of organic nitrogen in all series.

Results for 1929 show that the highest yield of seed cotton was obtained in the nitrate of soda series when all the nitrogen came from nitrate of soda, and a proportion of 25 per cent nitrate of soda and 75 per cent cottonseed meal gave the second highest yield. In the sulphate of ammonia series, the highest yield was obtained from the plat deriving all its nitrogen from the sulphate of ammonia, while a ratio of 65 per cent nitrogen from sulphate and 35 per cent from cottonseed meal gave the second highest yield. In the leuna-salpeter series, a proportion of 90 per cent inorganic nitrogen and 10 per cent organic gave the largest yield; while one having 65 per cent of its nitrogen from leuna-salpeter and 35 per cent from cottonseed meal ranked second in yield.

INCREASED LABOR EFFICIENCY IN COTTON PRODUCTION BY USING COMPLETE FERTILIZERS

Assuming an average labor requirement of 128 hours per acre to produce cotton, the following has been found from field experiments to be the average increase in labor efficiency on six types in the Coastal Plain and on four types of soil in the Piedmont section of North Carolina in the production of fertilized cotton over the crop unfertilized, as measured by yields:

Provinces and Soil Types	Yield Seed Cotton Per Acre—Pounds		Yield Seed Cotton Per Hour of Labor—Pounds		Increased Labor Efficiency From Fertilization —Per Cent	Times Increased Labor Efficiency by Use of Fertilizers
	Unfertilized	Fertilized	Unfertilized	Fertilized		
(1) FOR COASTAL PLAIN:						
Dunbar fine sandy loam	1,320	2,262	10 3	17.7	72	1.72
Portsmouth sandy loam	904	1,800	7.1	14.1	99	1.99
Ruston sandy loam	761	1,771	5.9	13.8	134	2.34
Wickham fine sandy loam	342	1,080	2.7	8.4	211	3.11
Norfolk sandy loam	536	1,540	4.2	12.0	186	2.86
Marlboro sandy loam	690	1,495	5.4	11.7	117	2.17
Averages	759	1,659	5.9	13.0	136.5	2.37
(2) FOR PIEDMONT:						
Cecil fine sandy loam	595	1,378	4.7	10.8	130	2.30
Davidson clay loam	550	1,270	4.3	9.9	130	2.30
Georgeville silt loam	415	1,160	3.2	9.1	184	2.84
Appling sandy loam	287	1,107	2.2	8.6	291	3.91
Averages	462	1,229	3.6	9.6	183.8	2.84

By deducting 300 pounds seed cotton produced by the fertilizers used on the different types of soil to pay for the cost of the fertilizers the net increase in the labor efficiency on an average, from the fertilized over the unfertilized cotton, has been found from experimental data to be increased 1.80 times for Coastal Plain and 2.01 times for Piedmont soils of the State.

CROP VARIETY, BREEDING AND CULTURAL EXPERIMENTS INCLUDING TECHNICAL COTTON FIBER INVESTIGATIONS

COTTON BREEDING

Inheritance of Seed-coat Characters in Cotton. During the past several years, the inheritance of the smooth, fuzzy-tip, and fuzzy characters of cotton seed have been studied. Strains, self-pollinated for several generations, and homozygous for these characters were used in making crosses.

The smooth seeded strain, isolated from the King variety, was entirely devoid of fuzz on the seed. The fuzzy seeded strain, also isolated from this same variety, was covered with a thick coat of short greyish-white fuzz. The seed of the fuzzy-tipped strain bore a small tuft of short fuzz on the tip end of the seed but was otherwise smooth or naked.

Cross: Smooth Seed X Fuzzy Seed. The seed of the F_1 plants were smooth, and in the F_2 716 smooth-seeded plants and 254 fuzzy-seeded plants were produced, giving an approximate ratio of three smooth to one fuzzy.

Cross: Fuzzy-tip X Fuzzy. The F_1 plants all produced fuzzy-tipped seed, while in the F_2 24 plants produced fuzzy-tipped seed, 18 plants fuzzy seed, and 6 plants were barren. The fuzzy-seeded F_2 plants produced only fuzzy-seeded plants in the F_3 plants. Four fuzzy-tipped F_2 plants produced in the F_3 generation 76 fuzzy-tipped plants and 22 fuzzy-seeded plants, indicating a 3:1 ratio with the fuzzy-tip character dominant.

Cross: Smooth Seed X Fuzzy-tip Seed. All plants in the F_1 generation bore smooth seed. In the F_2 generation 187 plants bore smooth seed, 45 fuzzy-tipped seed and 21 fuzzy seed, this being close to a 12:3:1 ratio.

The above findings suggest the following genetic constitution of the parental families:

Smooth parent	SStt
Fuzzy-tip parent	ssTT
Fuzzy parent	sstt

Smooth is dominant to all types of fuzz. The fuzzy-tip character is dominant to complete fuzziness but is recessive to the entirely smooth condition. This hypothesis was borne out in the F_3 generation of the cross smooth X fuzzy-tip (SStt X ssTT). Nine genotypes would be expected in the F_2 generation of this cross, three (SSTT, SSTt, SStt) of which would produce only smooth-seeded plants in the F_3 generation. One (ssTT) would produce only fuzzy-tip seed, one (sstt) fuzzy seed and the other four (SsTT, Sstt, SsTt, ssTt) would segregate, giving 4 different ratios. There was no means of distinguishing between the three genotypes which produced only smooth seed, unless further breeding work were done, using known testers. All other expectations were fulfilled, as is shown by the results given in the following table:

SEGREGATION IN THE F^2 GENERATION OF THE CROSS—SMOOTH X FUZZY-TIP (SStt X ssTT)

Character of F_2 Plants		Segregation in F_3 Generation		
Phenotypes	Genotypes	Smooth Seeded Plants	Fuzzy-Tip Plants	Fuzzy-Seeded Plants
Smooth	SStt	452		
Smooth	SSTt			
Smooth	SSTT			
Smooth	SsTT	166	49	
Smooth	SsTt	324	91	33
Smooth	Sstt	403		119
Fuzzy-Tip	ssTT		33	
Fuzzy-Tip	ssTt		298	102
Fuzzy	sstt			329

Cotton Improvement. Selection work for higher quality of staple, better yields, and better adaptation to boll-weevil conditions of the Mexican variety is being continued on the Central Station and at the Upper Coastal Plain and Piedmont branch station farms. A large number of plant-to-row progenies are grown each year, and strain tests, including the more promising pedigree strains, are conducted. Several of these strains have shown marked improvement over the parent variety in yield, uniformity of staple, and plant characters. In strain tests with high and low fertilization on the Upper Coastal Plain branch station, some strains were found better able to utilize heavy fertilizer applications than others.

Seed of new pedigreed strains were distributed to farmers the past season and larger amounts will be available another year.

During the season of 1929, crosses were made between several strains of the Mexican variety. The F_1 generation of these crosses are being grown during the summer of 1930. Some of these crosses appear to have more fruiting vigor than the parents. Excessive vegetative growth which might be expected in the F_1 plants resulting from some of these crosses did not show up, due probably to dry weather conditions as none of the cotton made a large growth this season.

Cotton Variety Experiments. Results of variety experiments conducted during the past three years show that the improved varieties, producing a staple length of 1 to 1 1/16 inches, have given largest money returns per acre. These length are in greatest demand by the mills of the Southeast as well as by the export trade. The highest yielding varieties producing a staple length of 1 to 1 1/16 inches are the Mexican strains, Cleveland Nos. 884, 5 and 20-3. The lighter foliaged varieties, such as Carolina Foster, are especially adapted for use on the heavier soils of the lower Coastal Plain section of the State. The Wannamaker-Cleveland "Standard" was the heaviest yielder in the short staple group.

Wilt Resistance. Fusarium wilt of cotton is very prevalent on the sandy soil types in certain areas of the State. Tests have been conducted in several localities to determine the resistance of different varieties to this disease.

Varieties bred for wilt resistance and also non-resistant varieties were included in these tests. These varieties showed much variation in susceptibility in 1929 as may be seen from the data contained in the following table:

COTTON VARIETY EXPERIMENT ON WILT-INFESTED SOIL (NORFOLK SAND-SANDHILL PHASE RICHMOND COUNTY

Variety	Yield Lint Cotton Per Acre	Staple Length—Inches	Per Cent Wilted Plants on August 28	Healthy Plants Per 100 Feet
Dixie Triumph (Watson)	198	7/8	6.7	116
Miller	140	15/16	40.3	61
Cook 307-6	224	5/8	4.2	152
Cook (Rhyne Bros.)	275	5/8	3.6	136
Cleveland 5-2	65	1	58.7	29
Cleveland (local)	96	7/8	52.9	30
Super-Seven No. 4	125	1 to 1 1/16	8.8	62
Lightening Express	161	1 to 1 1/16	30.7	62
Mexican 6-1-9	180	1	7.3	73
Rowden No. 40	143	15/16	26 2	72

The soil on which this experiment was conducted was also badly infested with nematodes, an examination of wilt-infected plants showed that in a large percentage of the plants the wilt organism entered through a nematode injury

Fig. 11.—Showing relative wilt-resistance of Mexican 58, Coker-Cleveland 884, and Rhyne-Cook varieties of cotton grown on Norfolk sandy loam in Wayne County. The following were the per cent of wilt infected plants on September 17, 1930:

Mexican 58 (left) 9.5
Coker-Cleveland and 884 (center) 87.8
Rhyne-Cook (right) 1.4

spot. Nematodes are found on most of the wilt-infested soils, and the tolerance or resistance of varieties to nematodes is evidently as important a consideration as is resistance to the wilt organism. Vigorous growing varieties, while not bred for wilt-resistance, held their leaves until the bolls opened, although the plants showed infection.

Peanut Variety Experiment. Results secured in 1929 in this experiment show that the largest yields were obtained from Improved Spanish, followed by the N. C. Bunch, Virginia Bunch and Jumbo Runner varieties in the order named. The value per acre of the nuts produced would depend on the market price for each type. The yields, per cent of hand-picks, grade, etc., are given in the following table:

PEANUT VARIETY EXPERIMENT AT THE UPPER COASTAL PLAIN BRANCH STATION

Variety	Yield—Pounds Per Acre	Per Cent Jumbo Handpicks	Per Cent Fancy Handpicks	Shelling Per Cent	U. S. Grade and Class	
					Grade	Class
Jumbo Runner (Hancock)	1,440	47.3	8.0	64.5	1	B
Jumbo Runner No. 5-24-3	1,215	51.4	8.5	66.5	1	A
Virginia Runner	1,410	27.3	22.0	65.8	2	A
Virginia (Jumbo) Bunch	1,485	32.0	21.1	66.0	2	A
N. C. Bunch	1,770	16.0	22.3	66.8	5	A
Improved Spanish 2B	1,830			71.2	1*	

*No. 1 grade for Spanish Peanuts.

Peanut Spacing Experiment. Results from this experiment with the Virginia Bunch variety planted in three-foot rows showed best yields from 4-inch spacing, one plant to the hill; and from 8 and 12-inch spacings, two plants to the hill. Reduced yields and many one-seeded pods were secured from spacing of 2 plants every 4 inches. Best yields were secured from the Jumbo Runner variety with 2 plants in the row, 12 inches apart; 2 plants 16 inches; 1 plant 12 inches apart; and 2 plants 8 inches apart, respectively. The closer spacings produced more of a determinate pod growth than did the wider spacings. The very thick spacings (4 inch, 2 plants to the hill) was not found to be desirable due to reduced yield, many one-seeded pods and an excessive top growth, which might prove to be objectionable during a dry season.

Peanut Breeding. Selection work for higher yield and better quality is being carried on with the Virginia Bunch variety at the Upper Coastal branch station farm.

Soybean Varieties. Tests, including a large number of varieties, were conducted at the Central Station and at four of the branch station farms during the summer of 1929. The highest yielding varieties for seed and hay on the three farms representing the Coastal Plain, Piedmont, and Mountain sections of the State are given in the following table:

HIGHEST YIELDING VARIETIES OF SOYBEANS FOR SEED AND FOR HAY

Farm	Yield of Seed		Yield of Hay	
	Variety	Bushels Per Acre	Variety	Pounds Per Acre
Central Farm (Raleigh) (6 years average)	Tokyo	21.6	Otootan	4,910
	Herman	19.2	Laredo	4,535
	Virginia	17.8	Herman	4,348
	Mammoth Yellow	17.3	Chiquita	4,148
Coastal Plain Farm (Willard) (5 years average)	Herman	25.5	Otootan	5,380
	Tokyo	25.3	Biloxi	5,080
	Mammoth Yellow	23.2	Laredo	5,020
Mountain Farm (Swannanoa) (8 years average)	Herman	23.0	Herman	
	Southern Prolific	22.5	Laredo	
	Virginia	21.3	Virginia	

Other promising varieties are the George Washington, a medium early non-shattering type; the Chiquita, a good hay variety; and the Dixie, an early, heavy seed producer which is adapted to the Upper Piedmont and Mountain areas. A large number of new introductions have been tried out during the past few years. Some have shown considerable promise but none have shown up superior to these varieties now being grown by farmers of the State. The more promising of these strains at the present time are Nos. 59853 and 71597.

Soybean Breeding. Selection work with natural hybrids from the Biloxi variety has been in progress for several years. These hybrids are apparently crosses between the Biloxi and Mammoth Yellow varieties, as some of the segregates show pod and leaf characters similar to the Mammoth Yellow variety. In progeny rows, which segregated for pod color, those plants which bore light yellow pods similar to the Mammoth Yellow shattered badly, while plants bearing dark brown pods like the Biloxi did not shatter.

A strain has been isolated which has the plant, leaf, pod and non-shattering characters of the Biloxi variety but which produces yellow seed.

Lespedeza Variety Experiments. Results of one year's work on the Coastal Plain branch station farm and in tests on private farms indicate that the Kobe and Tennessee No. 76 are best for hay, with Common as a third choice. Korean made a very poor growth in all tests in the Coastal Plain but does much better in the Piedmont, and for the higher elevations of the Mountain section of the State is better adapted than either of the other three.

Crotalaria Experiments. Thirty strains of Crotalaria, representing thirteen species, were grown on the Coastal Plain branch station farm during 1929. The most promising species were found to be the Cericea, Incana, and Striata. The yield of green material from these were 15, 13¾ and 11 tons, respectively. Drifferent strains of the same species showed marked differences in growth, earliness and adaptability. This crop has been found to be very promising

for soil improvement purposes, particularly for the light sandy soils of the Coastal Plain section of the State.

EXPERIMENTS WITH ALFALFA AND RED CLOVER

In Coöperation with the Bureau of Plant Industry of the U. S. Department of Agriculture

Alfalfa Experiments. Variety and source-of-seed experiments have been carried on at the Piedmont branch station farm since 1927. Utah, Kansas, and Dakota grown seed of the common variety have given uniformly good results. The Grimm variety has, too, been found to be well adapted and has produced good yields; however, farmers are not justified in paying the higher prices asked for these seed, since the common variety is sufficiently winter-hardy for this climate. The Hairy Peruvian and other seed from the southwest have usually been found to winter-kill badly.

The French strains, tested thus far, have been about equal to the American seed in hay-yielding capacity. Seed from South Africa and the Argentine Republic are somewhat subject to winter-killing, but produce good yields, provided they get through the first winter without damage to the stand.

Red Clover Experiments. The Tennessee Anthracnose-resistant variety has given a better stand and larger yield than has seed of any of the imported varieties. Some of the French seed have given a good stand and fair growth, others were poor. The use of seed from other foreign countries resulted in poor yields generally.

Spring seeding has given slightly better stand and growth than has fall seeding.

CEREAL EXPERIMENTS

The accumulated effects of continued selection is the most that has been accomplished during the past season. Outstanding results in improving cereal crops will come as a result of time an patience, and careful and continuous effort. A few definite results, however, have been obtained during the year which are noted below.

Corn. Variety tests of corn are now being conducted on four of the station farms—the Mountain, Piedmont, Central and Coastal Plain—this season closing a five-year continuous period of the tests. When the present crop has been harvested, dependable recommendations should be possible of the most suitable varieties for growing in each of the main soil provinces of the State represented by these farms.

The Biggs' Two-ear variety, as improved by field selection on the Mountain branch station farm, led in the variety test during the year. Because of its excellent qualities it has attracted the favorable comment of many leading corn-growers in the vicinity of the farm.

Weekley's Improved, the variety selected for further improvement at both the Piedmont and Tobacco branch station farms, has been improved, too, to such a stage as to receive the favorable consideration of growers of both sections. Both farms have received more orders for seed during the year than they could fill. A large seed firm in an adjoining state was so favorably impressed with the high-yielding qualities of this variety that it purchased considerable seed during the year from one of the farms for planting a field

on one of its seed-propagating farms. The plan of the Department is to develop this variety until it will easily take rank as a leading variety adapted for use in the Piedmont section of the State.

One of the most noteworthy corn tests undertaken this year was the one on the Mountain branch station farm to determine what variety is best adapted to poor land, which is a question frequently asked by farmers. To find an answer to this query, a variety test was conducted on a piece of poor land without fertilization, using five varieties—Hickory King, a comparatively poor yielder on fertile land; Biggs' Two-ear, the variety grown on the Mountain station farm; Jarvis's Golden Prolific, a yellow, medium yielding variety; Cocke's Prolific, a white medium yielding variety; and Big Corn, a single-eared, rank growing, late maturing variety. The results from this test are given below.

Rank	Variety	Yield Per Acre—Bushels
1	Hickory King	10.4
2	Biggs' Two-Ear	8.6
3	Jarvis' Golden Prolific	8.4
4	Cocke's Prolific	8.1
5	Big Corn	4.5

These varieties with eight others were included in the regular variety test which was located on fairly fertile bottom-land. The yields and rank in the regular test, of the same five varieties carried in the poor-land test, are given below.

Rank	Variety	Yield Per Acre—Bushels
9	Hickory King	25.2
1	Biggs' Two-Ear	38.1
7	Jarvis' Golden Prolific	28.6
9	Cocke's Prolific	25.2
3	Big Corn	37.2

Although it will require more than a single test to furnish adequate data, yet the contrast in the results of the two tests of a single year are very suggestive.

Among the experiments being conducted with interested corn growers, in addition to those conducted on the Station farms, was one which contained a feature of special interest. An ear-to-row-test was conducted with D. A. Kiser in Gaston County. When the field selections were made of ears to plant in the test, a stalk was found with four well developed ears. The two best were saved for planting in another test. The row planted from the higher yielding ear produced 64. 5 per cent more pounds of ears than the row planted from the lower-yielding ear from the stalk. This data seems to indicate that there is quite a

difference in merit in individual ears even when they are grown on the same stalk.

Wheat. Four varieties of wheat are being carried in the variety tests on both the Piedmont and Mountain branch station farms. Average yields for eight consecutive years have now been obtained with Fulcaster, Gleason, Purple Straw and Leaps Prolific varieties. These are not the only varieties carried in the tests, but their yields are to be taken as standards by which other varieties are to be measured. There are so far two outstanding observations from the results of the tests on both farms, which are as follows:

(1) The Fulcaster variety, or some improved strain of it, has always lead in the tests on both farms.

(2) The popular notion, quite generally held by growers, that an early maturing wheat will in a series of years outyield a later maturing one, is not borne out by the results thus far obtained. Purple Straw, the early variety carried in these tests as a standard, has yielded on the Mountain farm, in an eight-year average, 3.2 bushels per acre less than the late maturing Fulcaster, which difference amounts of 13.6 per cent less yield for Purple Straw. On the Piedmont farm, Fulcaster has out-yielded, for the same length of time, the early maturing Purple Straw by an average of 2.5 bushels per acre, which amounts to an increase of 8.9 per cent in favor of the Fulcaster variety. Further investigations, however, are necessary to be conducted before definite conclusions may be safely drawn on this point, but the facts thus far in hand are in favor of the use of the better of the later-maturing varieties.

A test of different dates of seeding of the Fulcaster variety seeded at the rate of 6 pecks per acre has been made on the Mountain branch station farm for the past three years. The dates of seeding, with average yields for each date are given below.

Date of Seeding	Average Yield Per Acre—Bushels
September 15	20.9
October 1	19.0
October 15	26.1
November 1	20.9
November 15	11.9

These results clearly indicate that about October 15 is the best date for seeding wheat in the mountain area of the State.

The most outstanding feature of the wheat work for this year consists in what is being attempted rather than in what has been accomplished. Selection work for seed improvement was begun in 1929. The head selections made in the field that season were planted in five-foot rows that fall. A total of 1058 of these head selections were planted, consisting of oats, barley, rye and of different varieties of wheat. The oats and barley were fewest in number. The oats were all winter-killed. After rigid elimination, 97 selections were made from the five-foot rows for further testing in rod rows during the season of 1930-1931. Also, about 1100 new head selections were made from the 1930 crops of wheat, rye and oats for planting in five-foot rows during

the coming fall. These selections all together may lay the foundations for the material improvement of the small grain crops of the State. The work now in force probably equals that of any of the other southern stations.

The rust resistant work with wheat has been continued in coöperation with the Department of Botany of this Station and the Bureau of Plant Industry of the U. S. Department of Agriculture. At this time, ten selections of especial promise from the standpoint of yield and resistance have been made for further trials in rod rows at the Mountain branch station farm. It is planned, too, to seed a large number of these rust-resistant strains on the Piedmont branch station farm during the coming fall.

Oats. The old problem is still with us of finding a high-yielding strain of oats that will not freeze-out during the winter. All the varieties of oats under experiment on the Piedmont farm were winter-killed during the past season, except the Lee, which survived with an estimated stand of sixty per cent. The Fulghum variety has proven the best yielder of all varieties so far tested at the different branch stations when it is able to survive the winter, but it is very subject to winter-killing. On the Mountain branch station, where only spring seeding is practiced, it is especially promising. An effort is now being made to develop by selection a cold-resistant strain. The Lee variety, developed by cereal workers in the Federal Bureau of Plant Industry, has proven so far the best winter oat for fall seeding in the Piedmont area of the State.

COTTON FIBER INVESTIGATIONS

The following projects have received attention during the year:

(1) A study of fiber diameter or "fineness" is being made in order to note any difference in the diameter of fibers from strains and varieties of cotton having the same length of staple.

No measurements have been made during the current year. Samples of cotton have been obtained from several varieties and strains grown at the Arkansas station and further studies will be made this year on these.

(2) A study of the uniformity and length of staple from pure strains of the Mexican variety grown at this station.

The average length, modal length, uniformity and per cent of waste of fibers from each promising strain were accurately measured. Significant differences were found in the 1928 crop, and the strains having an inferior staple were discarded. Material was saved from the crop of 1929 and measurements will be made during the coming winter. Samples will be saved, too, from the crop of 1930 for a continuation of the laboratory investigations.

(3) Studies concerning the relation of drag and other fiber properties to yarn quality are being made in coöperation with the Bureau of Agricultural Economics of the U. S. Department of Agriculture. Two lots of cotton showing contrast in drag were spun into yarns by H. H. Willis, Senior Cotton Technologist, Clemson College, S. C. The physical properties of the fibers from these cottons are being measured by this Department and a complete report will be ready at an early date.

(4) The effect of different combinations and amounts of fertilizing constituents upon the physical properties of fiber from cotton grown on different soil types is being investigated each season. This work was started in 1927

and measurements have been made of material from the crops of 1927 and 1928. Material was saved from the crop of 1929 and will be secured from the 1930 crop for measurements during the coming year. A report on the data secured for a period of years will be made at a later date.

Before closing this report I wish to commend most heartily each of the individual workers for his faithful and unselfish services in carrying forward the different lines of research of the Department. The information secured in this research intelligently applied in farming operations of the State should lead to the more general adoption of agricultural practices which will result in the more economic production of crops of better quality, and aid materially in bringing about a more contented and fuller rural life.

C. B. WILLIAMS,
Head Department of Agronomy.

RESEARCH IN ANIMAL HUSBANDRY

BEEF CATTLE, SHEEP AND SWINE INVESTIGATIONS

EARL H. HOSTETLER, in Charge
JOHN E. FOSTER, Assistant
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BEEF CATTLE PROJECTS

1. Quality of Meat (Blackland Branch Station, Wenona, N. C.).
(In coöperation with Bureau of Animal Industry and other State Experiment Stations)

The plan of work for this project has been changed so that the animals will be finished when approximately two years of age rather than as yearlings, therefore, no slaughter data are available for this year's report.

Improvements in physical equipment has been made so that each bull will be with his respective group of cows only during May, June, and July of each year. This definite breeding period will eliminate the factor of age in the animals that are to be finished for market.

The native cow herd is divided into two groups during the breeding season but during the other nine months they are all grazed or fed together. The two bulls, namely, pure bred Hereford and native, are separated only during the breeding season.

2. Vitamin A Studies (Central Station Farm).
(In Cöoperation with Dr. J. O. Halverson)

Six two year old steers were used in this trial with one being slaughtered at the beginning of the feeding period as a control and the other five being fed a ration of cottonseed meal, cottonseed hulls and beet pulp. Three steers were allowed to die, one developed pneumonia, and the other was cured by adding cod liver oil to the ration after he had lost his appetite and developed symptoms similar to those developed by the three steers that died.

(See Dr. Halverson's report for details of project.)

3. Comparison of Carbonaceous Roughages (Piedmont Branch Station, Statesville, N. C.).

Thirty head of two- and three-year old steers were purchased in Western North Carolina for this second year's work in comparing cottonseed hulls with corn stover as a roughage for steers that are to be fattened for market. The steers were divided into two equal groups and received the following average daily ration for a period of 114 days.

Average Daily Ration	Group 1	Group 2
Shelled Corn	8.65	9.28
Cottonseed Meal	8.65	9.28
Cottonseed Hulls	13.21	
Corn Stover		10.77

Groups 1 and 2 were both full fed, with 421 pounds of shelled corn, 421 pounds of cottonseed meal and 634 pounds of cottonseed hulls being required to produce 100 pounds of gain in Group 1, while in Group 2, 452 pounds of shelled corn, 452 pounds of cottonseed meal and 524 pounds of corn stover were required. The gains in the two groups were quite similar with the steers receiving cottonseed hulls making an average daily gain of 2.08 pounds and those receiving corn stover making an average daily gain of 2.06 pounds.

SHEEP PROJECTS

1. Control of Stomach Worms by Sanitation (Central Station Farm).

As was reported last year, the ewes were divided on January 23, 1929, into three equal groups of eight ewes each. Group I was the check lot and did not receive the sanitary measures practiced with Group III. Neither were the lambs in this group drenched as in Group II. Groups I and II were grazed on permanent pastures while Group III was allowed only temporary pastures that had not been grazed previously.

The drenching for the lambs in Group II was started on June 12. At this time Group I contained 9 lambs averaging 54.33 pounds, Group II 9 lambs averaging 59.56 pounds, and Group III 8 lambs averaging 45.13 pounds.

All of the lambs were weaned on July 10, and from June 12 to October 2 the lambs were weighed every two weeks and those in Group II were drenched every four weeks.

The wether lambs in each group were slaughtered at a weight of approximately 70 pounds, also at this time post-mortem examination was made for stomach worms.

It was found that the lambs slaughtered in Group I contained considerably more stomach worms than those in either of the other groups. Of the lambs slaughtered from Group III none contained many worms although most of them did contain a few. The degree of infestation of the lambs slaughtered in Group II seemed to vary closely with the length of time that had elapsed since their last drenching. When only a few days had elapsed they were found to be practically free from stomach worms, but when nearly a month had elapsed they were almost as wormy as the lambs slaughtered in Group I. The degree of infestation of lambs slaughtered from the same group at the same time also varied considerably. This was most pronounced on June 26th when two lambs from Group III were examined. No stomach worms were found in Lamb No. 69 while Lamb No. 79 contained a considerable number. The former was also 39 days older than the latter.

During the period from June 12 to October 2 three lambs in Group I died, apparently from stomach worms, and a number of others became unthrifty. The largest lamb in Group II died on June 19th, from hemorrhagic septicemia, and an old Hampshire ewe from Group III died on June 29th from an unknown cause, but no lambs died from stomach worms except in Group 1.

2. Upgrading of Native Eastern North Carolina Sheep (Central Station Farm).

A total of 12 ewes in addition to the pure bred Shropshire ram, were used in the project this year. Six of the ewes were the original Eastern North Carolina stock, three were first cross two year olds and three first cross yearlings. All wether lambs had been slaughtered when of sufficient size to be marketed. Each of the six original ewes and one of the two year old ewes lambed

during the early part of 1930. At lambing time, the six native ewes averaged 75 pounds in weight, while the two year old ewe weighed 121 pounds. All twelve ewes were sheared on May 15, 1930. The fleeces from the six native ewes averaged 2.87 pounds each, with an average staple length of 2.29 inches, those from the three 2-year-olds averaged 6.83 pounds, with an average staple of 3.42 inches in length, and those from the three yearlings averaged 6.17 pounds, with an average staple length of 3.83 inches.

When the three first cross two year old ewes are compared with their dams it is found that the use of a pure bred ram has increased the weight 50 per cent, the weight of fleece 138 per cent, and the length of staple 49 per cent. There has also been a decided improvement in the conformation of the first cross ewes and in the quality of their fleeces.

3. Control of Stomach Worms by Drenching (Piedmont Branch Station).

The work this year was started at the Piedmont Test Farm on June 10, 1929 with 10 grade Hampshire ewe lambs. Group I was drenched at 28 day intervals and Group II at 14 day intervals. Both groups were kept off feed for about 20 hours before drenching and off feed and water for about 6 hours after drenching.

At the start of the test both groups averaged 57.20 pounds. At the end of the first 28 day period the lambs in Group I averaged 61.60 pounds and those in Group II 64.40 pounds. During this period Group I made an average gain of 4.40 pounds or an average daily gain of .16 pounds, and Group II an average gain of 7.20 pounds or an average daily gain of .26 pounds.

For the 112 days, from June 10 to September 30, that the lambs were on test those in Group I made an average gain of 20 pounds, or an average daily gain of .18 pounds, while those in Group II made an average gain of 29.20 pounds, or an average daily gain of .26 pounds. The more frequent drenching showed an average gain of 46 per cent more for the entire period.

The six most desirable and best grown lambs were selected to be retained in the flock when the trial was closed. When this selection had been made it was found that four of these six lambs were from Group II. The other lamb in Group II was healthy, but was born later than the others and was too small. The other three lambs in Group I were lacking in vigor and one had been losing weight since August 5th.

4. Comparison of Temporary Pastures (Central Station Farm).

Twelve ewes were used for this work and they were divided into two equal groups, with each group containing three mature and three yearling ewes. Their average weight at the beginning of the test was 108 pounds. Sudan grass and soy bean pastures were compared but, as it was necessary to close the trial on August 9, so that the ewes could be bred, and the pastures were not ready until July 10th, data covering a period of only 30 days were obtained. During this time the group on Sudan pasture made an average gain of 8.33 pounds, while the group on soy bean pasture made an average gain of 20 pounds. In other words, both groups were furnished ample grazing during the period, but the soy bean group gained two and one-half times as much as those in the Sudan group.

5. Cost of Raising Lambs to Marketable Age (Upper Coastal Plain Branch Station).

Eleven grade ewes and a pure bred Dorset ram were used in this test, with the ram being allowed to run with the ewes during the breeding season from August 1 to November 15. During the rest of the year the ram and ewes were kept separate.

The Upper Coastal Plain Station is completely fenced and this work was planned so as to use crop gleanings, cover crops and pastures that had heretofore returned little or no revenue to the farm.

Ditch banks, fence rows, fence corners and untillable lands in the fields that were being cropped were used by the flock until the spring crops were planted. The flock was then maintained on available native, tame or temporary pastures until sufficient crops had been harvested so that crop gleanings and cover crops were available. However, the pastures grazed by the sheep were not of sufficient size or quality to be of particular value to other kinds of livestock.

During the winter when inclement weather made it desirable for the flock to be kept under shelter, soy bean hay and grain were fed. These feeds were also given, in addition to the crop gleanings and cover crops, during the lambing season, and as soon as the lambs were of sufficient size to eat grain they were fed a grain mixture from a lamb creep until they were ready to be marketed.

It was found that when the above plan was followed only 130 pounds of soy bean hay and 112 pounds of grain mixture were consumed per ewe during the year, and with the hay charged at $30.00 per ton and the grain mixture at 2 cents a pound, the total cost for the flock, exclusive of pasture and gleanings, was only $50.28, or an average of $4.19 for the eleven ewes and one ram. The returns from the flock consisted of 12 lambs and 94 pounds of wool. Prices for wool and lambs during this year were much lower than the previous season, but even with the wool selling for only 20 cents per pound and the lambs $10.50 per hundredweight, the average return per ewe amounted to $5.37.

SWINE PROJECTS

1. Mineral Supplements (College Farm).

Data were obtained on two phases of this experiment, namely: "Comparison of Mineral Supplements for Fattening Pigs" and for "Brood Sows." Due to some necessary changes in physical equipment it was impossible to start the fattening pigs on test until they had attained an average weight of 132 pounds, therefore, in order to slaughter them at weights approximating 200 pounds, the trial was closed at the end of a 41 day feeding period. The results show that when pigs having the above initial weights were used that the mineral supplements were of no benefit.

Four groups, of 11 pigs each, were used in this trial, and all were self fed free choice on shelled corn, fish meal, and mineral, excepting Group 1, which did not receive any mineral. The mineral mixture in Groups 2 and 3 consisted of ground limestone, superphosphate and salt, while a commercial mineral mixture was fed to Group 3; dolmitic limestone was used in Group 2 and calcitic in Group 3.

The average daily gains for the four groups of pigs in their respective order were 1.68 pounds, 1.63 pounds, 1.60 pounds, and 1.53 pounds, while the feed required to produce 100 pounds gain in the respective groups was 377 pounds, 399 pounds, 428 pounds, and 427 pounds.

The sow herd was divided into two groups with both being fed the same grain mixture, but in addition Group 1 was fed a mineral mixture consisting of calcitic limestone, superphosphate and salt, while Group 2 received a commercial mineral mixture.

Five sows in Group No. 1 farrowed an average of 9.8 pigs to the litter, with an average birth weight of 2.3 pounds. An average of 5.6 pigs per litter were raised and the average weight per pig when weaned was 29.2 pounds.

In Group 2 an average of 9.7 pigs per litter were farrowed and 7.0 raised. The average birth weight was 2.5 pounds and the average weaning weight 28.9 pounds per pig.

2. Cottonseed Meal for Fattening Pigs (Swine Research Farm).

Twenty-two pigs were divided into two groups and self fed free choice for a period of 78 days. Both groups received shelled corn and mineral, but Group 1 was fed fish meal alone as the protein supplement, while that for Group 2 consisted of a mixture containing 2 parts of cottonseed meal and 1 part of fish meal.

The performance of the pigs in the two different groups was quite similar, since Group 1 made an average daily gain of 1.67 pounds and required 408 pounds of feed to produce 100 pounds of grain, and Group 2 made an average daily gain of 1.66 pounds and consumed 401 pounds of feed for each 100 pounds of gain produced. However, the profit was greater for Group 2 because of the lower cost of the cottonseed meal. The pigs in Group 2 consumed, during the 78 day period, an average of .58 pound of cottonseed meal daily per pig, and of the total feed eaten, 8.72 per cent was cottonseed meal.

A summary of previous work at this station shows that the daily gains were increased 11.3 per cent, the feed required (exclusive of minerals) was decreased 2.8 per cent, and the profit increased 29.4 per cent, when a mixture containing equal parts of cottonseed meal and fish meal was used as a protein supplement to corn for fattening pigs instead of fish meal alone.

The cottonseed meal feeding work has been expanded this year to include 9 per cent of cottonseed meal in a ration for brood sows, but as yet no results are available.

3. Cost of Raising Pigs to Weaning Age (All Stations).

The results from this project were published in Station Bulletin No. 272 in May, 1930.

4. Study of Factors Causing Lameness and Disease Among Swine (Blackland Branch Station and Swine Research Farm).

(In Coöperation with Dr. J. O. Halverson)

Difficulties have been experienced over a period of five years with fall farrowed pigs at the Blackland Branch Station when they are being finished for the spring market, on a ration of white corn, fish meal and mineral. It had been the practice at this station when this condition appears to allow the pigs to have access to green rye pasture, in order to bring them to a good

marketable weight in satisfactory condition, but in order to study the problem more intensively seven pigs, together with sufficient feed for them, were shipped to the Swine Research Farm near Raleigh. (See report of Dr. J. O. Halverson for results in detail.)

5. Comparison of Protein Supplements (Blackland Branch Station).

One hundred and thirty-four pigs were used in two seperate feeding trials to compare a mixture of equal parts of soy bean oil meal, fish meal, and cottonseed meal with fish meal alone as protein supplements to corn for fattening pigs. The first trial continued for 69 days with the pigs in both groups having average initial weights of 82 pounds. At the end of the feeding period the pigs receiving fish meal alone weighed an average of 208 pounds, while those receiving the mixed protein averaged 218 pounds per pig. The pigs in the second trial were started on feed with average initial weights of 96 pounds and at the end of a 68 day feeding period those receiving fish meal alone weighed an average of 219 pounds, while those from the mixed protein group averaged 231 pounds.

When the results from the two trials are combined it is found that the pigs receiving the protein mixture made 9.15 per cent greater gain at a cost of 3.12 per cent less per 100 pounds gain than those pigs that received fish meal alone as their protein supplement.

6. Quantity of Salt for Curing Meat (Central Station).
(In Coöperation with Miss Mary E. Thomas)

Certain pieces of pork, when prepared for the table, are declared by the consumer to be too salty. The question then naturally arises as to whether too much salt was used in the "cure" or whether the meat was left in "cure" too long.

The following data were obtained from an experiment planned so as to gain information on this question. Thirty-six pieces of pork were divided into three equal groups before being put into the "cure." Three pounds of brown sugar and 3 ounces of salt petre were used to each 100 pounds of meat in each group, and in addition 8 pounds of salt was added to the "cure" for Group 1, 12 pounds for Group 2, and 16 pounds for Group 3. Each of these groups was again divided so that one-half of the meat in each group was left in the "cure" three days per pound and the other one-half four days per pound.

When the curing and smoking processes had been completed, all of the meat was allowed to age for 30 days before being sampled. Two uniform samples were then taken from each piece, one being fried and tasted by a committee of five judges, and the other being parboiled and analyzed for salt by the "Standard Salt Test."

The results from both the judging committee and the chemical analysis show that the pork that was left in the "cure" the greatest length of time and that which was cured with the larger amounts of salt, showed the greatest saltiness when prepared for consumption. The amount of salt, however, was not necessarily a true indication of the palatability, since some of the bacons containing the most salt were preferred by certain of the judges, but in every case the hams and shoulders containing the lesser amounts of salt were more desirable.

The pieces that were left in "cure" three days for each pound of meat had an average salt content of 5.16 per cent, while those that were left four days per pound had an average salt content of 6.32 per cent. Those pieces that were cured with 8 pounds, 12 pounds and 16 pounds of salt contained, respectively, 5.22 per cent, 5.84 per cent, and 6.28 per cent of salt.

7. A Study of Utilization of Crops (Upper Coastal Plain Branch Station). (In Coöperation with Agronomy Department)

Three one acre plats are used in this project, with each one being planted to a three year rotation of corn, cotton, and soy beans. This year all plats grew soy beans and on two of these the soy beans were harvested with pigs and in the fall were seeded to Abruzzi rye, which was grazed by sows and their suckling pigs. The three plats were planted and tilled in an identical manner, but the crop from Plat 1 was harvested by hand and no pigs were allowed on it, that from Plats 2 and 3 was harvested by pigs. Plats 2 and 3 received the same kind and amount of fertilizer, but on Plat 3, 80 per cent of the fertilizing constituents of the feeds fed the previous year were deducted from the amount of fertilizer applied.

Six 70 pound pigs were used in each of the Plats 2 and 3, and in addition to the soy beans each group was fed a 2 per cent ration of shelled corn daily and self fed free choice fish meal and mineral. The pigs were kept on the soy beans for 98 days and during this period those in Plat 2 made an average daily gain of .85 pounds and consumed 321 pounds of concentrates for each 100 pounds gain.

During the month of October, after the soy beans had been harvested, Abruzzi rye was seeded in each of the three plats.

From February 14 to April 1, or 46 days, the rye in Plat 2 was grazed by a sow and four suckling pigs, while in Plat 3 another sow and her four pigs were allowed to graze the rye in this plat.

Corn, fish meal and mineral were fed in addition to the rye pasture to both groups. The sow and her four pigs in Plat 2 consumed 549 pounds of concentrates and gained 160 pounds during the 46 day grazing period, while those in Plat 3 consumed 572 pounds of concentrates and gained 147 pounds.

8. Value of Permanent Pasture for Fattening Pigs (Swine Research Farm).

The work on this project was continued this year with 45 pigs having average initial weights of 54 pounds. They were divided into three equal groups and were all full fed a ration of corn meal, wheat shorts, fish meal and mineral. Group 1 was confined in a dry lot, while Groups 2 and 3 were each allowed one-half acre of orchard grass pasture in addition to their concentrates. The ration for Groups 1 and 2 was identical, but for Group 3 the ration contained only one-half the amount of high protein feeds (shorts and fish meal) as that in the ration for the other two groups.

The pigs in each group were continued on feed until they had attained an average weight of 200 pounds. It required 91 days for the pigs in Group 2 to reach this weight, while 96 days were necessary for the pigs in both Group 1 and Group 3.

The amount of grass consumed was estimated by weighing the grass clippings from an ungrazed area in each plat and comparing this weight with

that of clippings from an equal area that had been grazed. It was found by this method that the pigs in Group 2 consumed 1911 pounds of grass and those in Group 3, 1895 pounds.

Not only did the pigs in Group 2 require fewer days to reach the prescribed weight, but they also consumed less feed per unit of gain. The average daily gain for the three groups in their respective order was 1.55 pounds, 1.61 pounds, and 1.55 pounds; the total feed required per 100 pounds gain was 354 pounds, 348 pounds and 369 pounds; and the cost per 100 pounds gain was $9.04, $8.88, and $9.27.

9. Soft Pork (Swine Research Farm).
(In Cooperation with Dr. J. O. Halverson, Bureau of Animal Industry and other State Experiment Stations)

The Soft Pork work was continued this year for the purpose of gaining further information on the value of cottonseed meal in the hardening ration for pigs that have previously been fed peanuts. Thirty-six pigs, representing two weight classes, were selected for this work, thirteen being started on their experimental feed with initial weights of approximately 35 pounds, and twenty-three with initial weights approximating 60 pounds. Sixteen additional pigs were used in order that their carcasses might be compared with those from pigs that had been fed cottonseed meal. Eight of these were fed a peanut ration throughout the trial and the other eight received a corn ration for the same period. The results from the carcasses of pigs that had been fed cottonseed meal following peanuts were not as satisfactory this year as during the three previous years, in that, according to the physical grading, eleven of the carcasses were either soft or medium soft. However, the chemical analysis of the back fats indicated that all carcasses were either hard or medium hard.

Samples of ham taken from representative carcasses did not show any consistent differences in palatability.

ANIMAL NUTRITION INVESTIGATIONS

J. O. HALVERSON, *In Charge*

The work this past year has been concerned chiefly with four projects: that of hardening peanut-fed pigs by the use of corn, tankage, mineral mixture and cottonseed meal; a study with steers of the relation of vitamin A to the feeding of cottonseed meal; a study of factors causing lameness and death among pigs at the Blackland sub-station at Wenona when corn, fish meal and mineral mixture are fed growing pigs in fattening for market; a study of the components of vitamin B complex in peanuts and its by-products, and the study of the effect on the albino rat of the ration on health, reproduction and ability to rear young.

The project, "a study of the components of vitamin B complex in the peanut and its products," is nearing completion. The data is being prepared for publication. A manuscript, "The Investigations in the Feeding of Cottonseed Meal to Cattle," has been completed and is in press. There is also in preparation with Mr. Earl H. Hostetler a pamphlet on "The Feeding Value of Peanuts to Growing Pigs."

At the spring meeting of the American Chemical Society, two papers were given by F. W. Sherwood and the writer: The Distribution of Vitamin B and Its Components in the Peanut, and The Toxicity of Cottonseed Meal.

Work is being done on the estimation of gossypol in cottonseed meal on sale in the State. The past winter considerable time was spent by Mr. F. H. Smith in modifying the method for the estimation of minute amounts of gossypol that are present in the meal. It was desired to obtain a method which would accurately estimate these small amounts. Work on the method has been practically completed.

NATIVE FORAGE PLANTS OF EASTERN NORTH CAROLINA

Chemical analyses of two native plants of the eastern swampy part of the State have been made. These are Reed Grass, Arundinaria tecta, and the Sensitive Joint Vetch, Aeschenomene virginica. The reed grass grows densely in the low lying areas of this part of the State. It is used to a limited extent to pasture cattle and work stock. Two samples were taken, one at Washington, N. C., which consisted of both the stems and blades of the upper portion of the plant. The other was taken in the black land area at Wenona. It consisted chiefly of the blades of grass with some stems. The analyses are given in the table below.

The sensitive joint vetch is a tall annual plant of the legume family, native in Virginia, the Carolinas and along the coast to Florida. In the lake bed of Lake Mattumuskeet, an area of seven to eight thousand acres, it has found a luxurious habitat. The plant grows about five feet tall, is of a deep green color. The lower part is woody and the stem hollow. It is said to be palatable to grazing cattle.

A green sample was submitted for analysis. This was divided into two portions, the upper half which contained the leaves, and the lower half, a woody fibrous portion which contained no branches or leaves.

It was desirable to ascertain its feeding value in nutrients. This was done and is reported here as a matter of record.

REED GRASS (ARUNDINARIA TECTA)

Per Cent	Water	Ash	Crude Protein	Fiber	Nitrogen Free-Extract	Fat
At Washington	7.4	7.7	10.1	32.8	37.5	4.6[1]
At Wenona	10.0	7.0	14.8	29.9	34.0	4.3[1]

SENSITIVE JOINT VETCH (AESCHENOMENE VIRGINICA), AT NEW HOLLAND

Upper Half	62.1	2.4	7.0	13.2	14.4	1.0
Lower Half	60.9	1.5	2.6	20.8	13.7	0.5

[1]Contained a green colored pigment, chlorophyll (?).

The analysis shows that the dry blades and the upper portion of the stem of the reed grass contain good nutrients, protein, fat and ash.

The upper half portion of the green sensitive joint vetch also contains considerable protein, the usual amount of fat and ash and not an unusual amount of fiber compared to the lower woody portion which contained one-fifth fiber.

The upper portions of these native plants show good feeding value in nutrients for grazing cattle.

SOFT PORK

(In Coöperation with Mr. Earl H. Hostetler)

This work has been continued in the same manner as in previous years. Limited amounts of shelled peanuts were fed for six weeks to 44 pigs. Eight additional pigs received corn throughout the experiment, while eight of the 44 pigs received all the peanuts that they would consume throughout the experimental period. These graded oily.

The hardening ration fed, following shelled peanuts for both weight classes of 35 and 60 pound pigs, was the same for all pigs. This is given in Table 1. In Table 2 are given average results of the Year's work. It is seen that the chemical grading is satisfactory and in agreement with the results of the previous years when cottonseed meal was used to harden pigs on a corn

TABLE 1

DATA ON FEEDING AND RATIONS

Lot	Method of Feeding	Weight			Pounds Fed		Ration—Peanuts* supplemented followed by:
		Initial	Final	Change	P'nts	Corn	
A	Individually fed	40	217	83	75.9	383.9	Corn, tankage and C. S Meal
B	Individually fed	64	225	98	71.0	367.4	Corn, tankage and C. S. Meal
C	Lot, hand fed	37	221	80	95.1	431.4	Corn, tankage and C S. Meal
D	Lot, hand fed	60	231	101	88.8	386.0	Corn, tankage and C. S. Meal
E	Lot, hand fed	66	225		193.5		Peanuts supplemented throughout
F	Lot, hand fed	62	229			525.2	Corn supplemented throughout
G	Lot, self fed	64	228	101	73.3	452.3	Corn, tankage and C. S. Meal

* Salt and mineral mixture was supplied with all rations.

TABLE 2

AVERAGE RESULTS OF CHEMICAL FAT DATA

Lot No.	No. Pigs	Average M. Point		Iodine No.		Refractive Index		Average Grade	
		Back	Kidney	Back	Kidney	Back	Kidney	Chemical	Physical
A	3	44.6	46.7	62.6	55.8	1.4596	1.4587	Hard	Med. Soft
B	3	44.9	47.2	62.8	54.3	95	86	Hard	Med. Soft
C	10	45.5	47.2	58.5	54.9	92	87	Hard	Med. Hard
D	10	44.9	47.0	60.3	56.1	94	87	Hard	Med. Hard
E	8	Solid[1]	Solid[1]	96.9	98.0	638	638	Oily	Oily
F	8	36.0	43.0	60.3	52.5	95	81	Hard	Hard
G	10	43.1	45.2	62.0	56.5	94	87	Hard	Med. Hard

[1]At 1° C.; One semi-solid.
[2]At 1° C.; Four semi-solid.

ration. The results of the constants of the back and kidney fats when the corn ration alone without cottonseed meal was fed, were not so uniform.

The results are satisfactory and in agreement with that of the three preceding years except the judging data, which are not in agreement with the chemical grading.

The average melting points of the back and kidney fats (Table 2) where cottonseed meal is fed following peanuts in Lots a, b, c, and d, are pronounced compared to those of Lot f, where corn is fed throughout without cottonseed meal.

STUDY OF VITAMIN A IN RELATION TO FEEDING COTTONSEED MEAL AND HULLS IN LARGE AMOUNTS TO CATTLE

(In Coöperation with Mr. Earl H. Hostetler)

This project has been continued in an effort to show that the deficiency of vitamin A in a ration consisting of cottonseed meal, hulls, and beet pulp with mineral mixture, causes sickness in cattle.

The steers were fed cottonseed meal, hulls, beet pulp, and mineral mixture with the results given below, Table 1:

TABLE 1

Steer No.	Disposition	Days	Changes in Ration	Weight		Gain or Loss, %
				Initial, Pounds	Final, Pounds	
6	Slaughtered	At Start	Stock	680	720	5.9
3	Died	165	None	825	650	—21.2
4	Died	164	None	745	720	—33.6
5	Died	185	None	835	940	12.6
1	Slaughtered	454	Various[1]	835	1,330	59.3
2	Died	366	Various[2]	815	923	13.3

[1]On basal ration 186 days when became sick and taken off; then fed cod liver oil 52 days though sick 82 days; upon recovery put back on basal ration for 95 days when became sick; began feeding cod liver oil for 115 days. Recovered and slaughtered.

[2]On basal ration alone 219 days when became sick for 60 days; then placed on pasture 30 days. Upon apparent recovery placed second time on basal ration for 26 days. Caught a cold, became sick and died 30 days later.

BIOLOGICAL DATA

On the basal ration of cottonseed meal, hulls, and beet pulp with mineral mixture three steers died (Tables 1 and 2); Nos. 1 and 2 became sick. One of these, No. 1, was cured by the feeding of cod liver oil, while No. 2 never fully recovered. The livers of all these steers were fed to rats suffering with ophthalmia. These rats responded according to the ration that had been fed to the steers. When alfalfa hay or cod liver oil had been fed and the steers cured, vitamin A was found to be present in the liver. When the steers were fed the basal ration alone no vitamin A in the livers of the steers could be detected.

TABLE 2

BIOLOGICAL DATA ON LIVER OF STEERS

Steer No.	Ration Fed	Vitamin A in Liver
6	Control—A good ration	Present
1	Cured by feeding cod liver oil	Present
2	Some cod liver oil and alfalfa fed	Some present
3	Basal ration alone	None present
4	Basal ration alone	None present
5	Basal ration alone	None present

Nine lots of young growing rats have also been fed cottonseed meal with various adjuvants. Where vitamin A was not added to the cottonseed meal, the rats did not grow normally. Their livers were, in some instances, fed to rats suffering from vitamin A deficiency for the purpose of detecting the presence of vitamin A storage.

The cottonseed meal fed experimentally and meals taken on the open market were also analyzed for their content of gossypol. These meals will also be tested for the presence of vitamin A by feeding them to rats suffering from vitamin A deficiency.

The feeding to rats of cottonseed meal supplemented in various ways has confirmed the deficiencies in cottonseed meal. Minerals and vitamin A are lacking in the meal and possibly other factors.

STUDY OF FACTORS CAUSING LAMENESS AND DISEASE AMONG SWINE AT THE BLACKLAND BRANCH STATION, WINONA

(In Coöperation with Mr. Earl H. Hostetler)

Pigs at the Blackland Test Farm fed white corn, fish meal and minerals for fattening, may quit eating, develop lameness, and in some cases, die. The disease appears sporadically, more often in the spring from the fall farrowed litters. It is known that green rye pastured a few days by the afflicted pigs will cure them.

Weaned pigs and feed from this section of the State were brought up to the Central Station, where seven pigs were fed and kept on concrete pavement with the results given below.

TABLE 1

RESULTS—WENONA PIG EXPERIMENT—9/13/30

RATION: White Corn, Fish Meal, Minerals

Pig No.	Disposition	Nutritive Supplements Or Changes Made in the Ration	Vitamin A Content in Liver of Pigs
1	Died	None	None—Rats died with ophthalmia
2	Slaughtered	+ Cod liver oil	Present—Rats cured of ophthalmia
3	Slaughtered (injured foot)	+ Cod liver oil	Present—Rats cured of ophthalmia
4	Died	None	None—Rats died with ophthalmia
5	Slaughtered	Yellow corn substituted	Present—Rats cured of ophthalmia
6	Still living	+ Cod liver oil, 2 ozs., later alfalfa meal and 4 ozs. C. L. O.	
7	Died		None—Rats died with ophthalmia

TABLE 2

CONDITION, 9/13/30, OF GARNER FARM PIGS AFTER 235 DAYS FEEDING

Pig No.	Condition	Nutritive Supplements or Changes Made in the Ration
8	Dizzy—Living	None
9	Improving	+ 6% alfalfa meal in white corn ration
10	Improving	— substituted yellow corn
11	Off-fed and dizzy	None

Later four weaned pigs from the Central Station were fed this same ration. In about the usual time, these pigs behaved in a similar manner. Then yellow corn or alfalfa meal was substituted or added to the ration. This resulted in a marked improvement in the condition of the pigs. Their appetite returned and they began to gain in weight. These pigs are now being fed as shown in Table 2.

The addition of cod liver oil or the substitution of yellow corn to the ration alleviated the sickness of five of the pigs. The livers of these pigs fed to vitamin A deficient rats, caused them to respond, depending upon whether or not the Wenona pig ration had been supplemented with substances containing vitamin A.

Six lots of rats have also been fed the Wenona pig ration. In some cases yellow corn has been substituted for white corn or cod liver oil has been fed with and without dried brewer's yeast.

The effect of the addition of cod liver oil to the ration could be demonstrated by the presence of vitamin A in the livers of the rats to which these supplemented rations had been fed. The presence of dried brewers' yeast in the ration prolonged the duration of life and of growth of the rats, but it did not take the place of cod liver oil.

The fish meal fed to the pigs on this ration was found to be deficient in vitamin A.

This experiment is still in progress. Further work must be done in order to prove that vitamin A is the chief deficiency and that when this is supplied, this defect of the ration and its effect upon the pigs, will be corrected.

THE COMPONENTS OF VITAMIN B OF RAW PEANUTS AND PEANUT MEAL

(In Coöperation with Dr. F. W. Sherwood)

The study of the distribution of the components of vitamin B complex in the structural parts of the Virginia Runner Peanut has been completed. The study with commercial peanut meal is almost completed. The data are being prepared for publication.

STUDY OF THE EFFECT OF THE RATION ON THE ALBINO RAT IN RESPECT TO HEALTH, REPRODUCTION AND ABILITY TO REAR YOUNG

(In Coöperation with Dr. F. W. Sherwood)

The peanut ration without the use of green feed or liquid whole raw milk has been continued. Its object is to produce normal reproduction and to formulate a dry ration which will give good vigorous young. The past year two changes have been made: that of using eight per cent dried beef liver without the use of 16 per cent ether extracted wheat embryo middlings, and that of adding to the ration 7.5 per cent dried brewer's yeast.

To date, October 17, 1930, these two rations, with these changes, have given F_1 and F_2 generations. The previous ration (192 F) was reported in detail in the Fifty-second Annual Report of the N. C. Agricultural Experiment Station, 1929. The F_5 generation has been produced on this ration and F_{11} on Ration 192 Modified.

Fair sized young, although somewhat small compared to our stock young, have been produced during the nursing period. As soon as they begin to eat the ration, they overcome this stunting effect.

The cereal ration, 193 C, without the use of green feed and liquid, raw whole milk has been modified to 193 D and 193 E. Ration 193 E consists of omitting 4 per cent wheat germ middlings and adding 4 per cent dried brewer's years. Ration 193 D was given in the Annual Report of last year. The F_4 generation has been produced on Ration 193 D and F_1 to date on Ration 193 E.

DAIRY INVESTIGATIONS

(C. D. Grinnells, in Charge)

The research work in dairying is a continuation of the studies reported last year. The pasture data collected during this season is very promising when we consider the adverse conditions they were subject to in the way of limited rainfall. Some small additions and improvements have been made to the dairy equipment during the year.

DAIRY CATTLE PASTURE MANAGEMENT STUDIES I

Heavy early grazing is considered by many to be an important factor in preventing the development of a good sod. This study is a comparison of heavy early grazing with medium early grazing. Two comparable plats are grazed as follows:

Plat I is being grazed by four cows. (Normal or medium grazing.)

Plat II is being grazed by five cows. (Heavy grazing.)

At the end of the grazing season Plat I (medium grazing) appears to be in a much better condition than Plat II (heavy grazing). Platt II, however, improves much when not pastured and at the beginning of the next pasture season there is much less variation in the two plats than there appeared to be in the fall.

The following is a description of the two plats at the end of the pasture season on November 4th, 1930:

Plat I. (Medium grazing.) The sod in this plat carries a greater percentage of orchard grass than Plat II. It also has a good proportion of blue grass

and red top. Both plats carry a good amount of clover, but the turf is largely made up of grasses and appears to be more dense in Plat I. There is a very thin scattering of Bermuda in both plats. The sod is in excellent condition.

Platt II. (Heavy grazing.) This sod is made up of a good percentage of blue grass, red top and orchard grass. It is closely grazed but the sod is even and covers the land well. The clovers appear thin at the present time. This plat also shows a small percentage of lespedeza. Both plats received the same grass mixture at the time of seeding. These two plats were pastured for 199 days. This makes a total of 796 cow days on Plat I and 995 cow days on Platt II.

This is a coöperative project with P. H. Kime of the Agronomy Division.

BOVINE INFECTIOUS ABORTION

This is the continuation of the study of a plan to control and eradicate Bovine Infectious Aborton or Bangs Disease.

The project was started with twenty-five to thirty representative dairy herds. The data shows that complete segregation plus good sanitation will bring good results. One of the big handicaps in making greater progress is a lack of confidence in the agglutination test. In a great many cases the irregularity charged to the test is due to a difference in the breeding state of the individual in question or to a lack of proper and permanent identification of the animal tested, thus enabling a correct identification on the sample.

In coöperation with Dr. William Moore and Dr. L. J. Faulhaber, Veterinary Division of the North Carolina Department of Agriculture.

CORN SILAGE

CORN SILAGE VERSUS SORGHUM SILAGE

MILK AND BUTTERFAT PRODUCED DAILY PER COW

Ration	Milk	Butterfat	
	Pounds	Per Cent	Pounds
Corn Silage	18.1	3.95	.716
Sorghum Silage	18.1	3.82	.692

The feeding trial covered a period of 120 days. The corn silage was of poor quality, the grain being very limited in quantity and quality. The results at this station appear to indicate that sorghum silage is of superior quality to corn silage when both are raised under similar conditions on poor land.

DAIRYING AS A SUPPLEMENTARY ENTERPRISE

This is the continuation of the study of dairy cattle as a supplementary enterprise to cotton farming in North Carolina.

The cropping plan has been partly changed and instead of continuing a three year rotation of corn, soybean hay and cotton on fields Nos. 1, 2 and 3, and the check plots Nos. 5, 6 and 7, the hay land is to be seeded one-half to soybeans and one-half to lespedeza. The only change in the original cropping

plan, therefore, will be from corn, soybean hay and cotton, to corn, hay and cotton with the hay land devoted to soybeans and lespedeza.

The livestock plan was changed and the number of head of stock to be carried on this project is to be increased from 4 to 6 head, as stated in the original outline, to 8 head. This number will comprise 5 cows, 2 heifers, and 1 calf. This herd is being managed under conditions that can be equaled by any farmer. The data from the study will therefore be comparable to farm conditions. During the last year the herd has been made up of 6 cows in their first lactation and two heifers. The first lactation periods have not yet been completed, but to date the herd average for these immature cows is 230 pounds of butter fat.

This is a coöperative project with the Farm Management and Agronomy Departments.

DAIRY CATTLE PASTURE MANAGEMENT STUDIES II

This is a continuation of the study of an Intensive System of Grassland Management under Southern conditions. A good turf is considered necessary for an efficient use of commercial fertilizer. This study is being conducted on land that is typical of the waste land of the State and the sod was not of a good character at the start. With this system of management the marked improvement in the character of sod has been noted.

The following table shows the plant food per acre to each plat:

		N	P_2O_5	K_2O
Plat 1		100½	75	37½
Plat 2		100½	75	
Plat 3	Check			
Plat 4	Basic		75	37½
Plat 5		79½	75	37½
Plat 6		58½	75	37½
Plat 7	Check			
Plat 8		37½	75	37½

This is a coöperative project with P. H. Kime of the Agronomy Division.

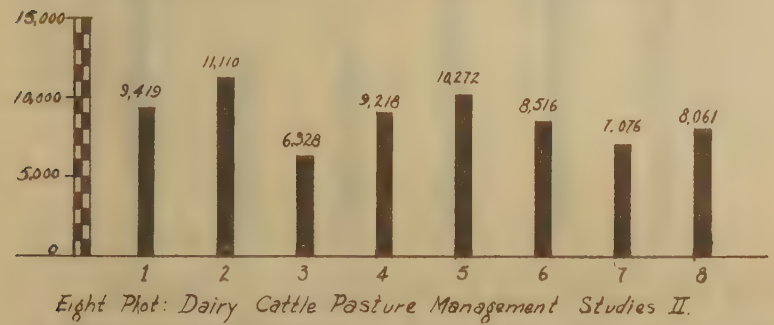


Fig. 1.—Yield of milk in pounds per two and a half acre plots during the 1930 pasture season, showing the influence of pasture fertilization upon milk yields.

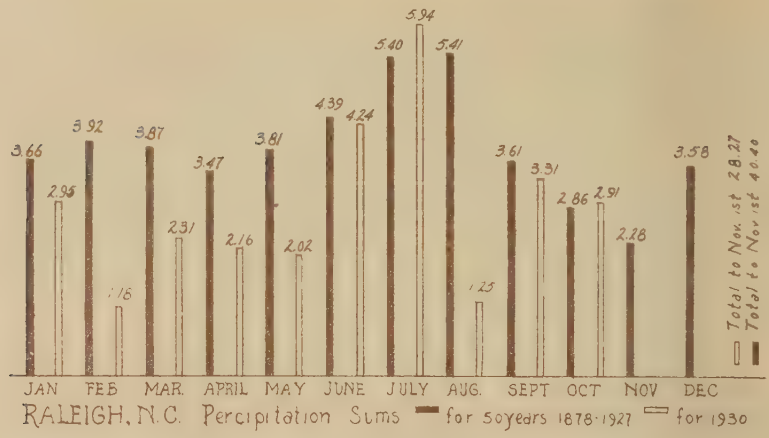


Fig. 2.

MOUNTAIN BRANCH STATION

DAIRY HERD DEVELOPMENT

This is a continuation of the study of herd development when young sires with pedigrees indicating production are used.

This herd completed its fourth yearly record on December 31, 1929, with a yearly average production of 376 pounds of butter fat per cow. Eight cows are now on official test and their records to date are very promising.

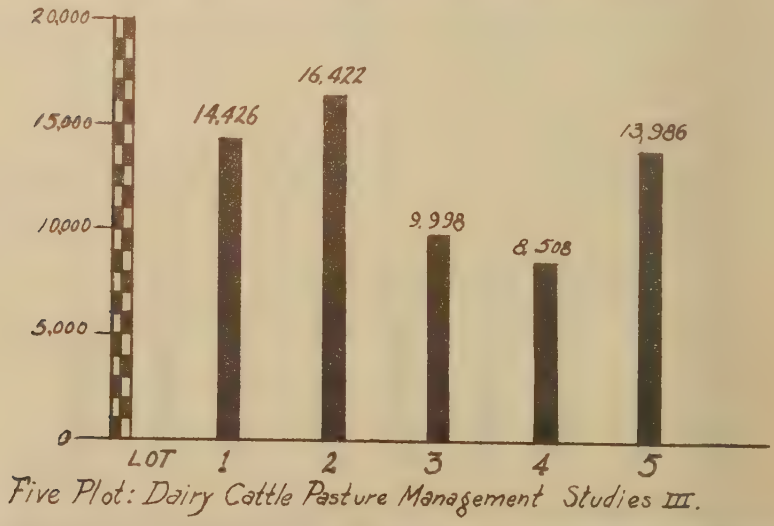


Fig. 3.—Yield of milk in pounds per three acre plots during the season, showing the influence of pasture fertilization upon milk yields.

DAIRY CATTLE PASTURE MANAGEMENT STUDIES III

The intensive system of grassland management has many features which should make it very practical under Western North Carolina conditions.

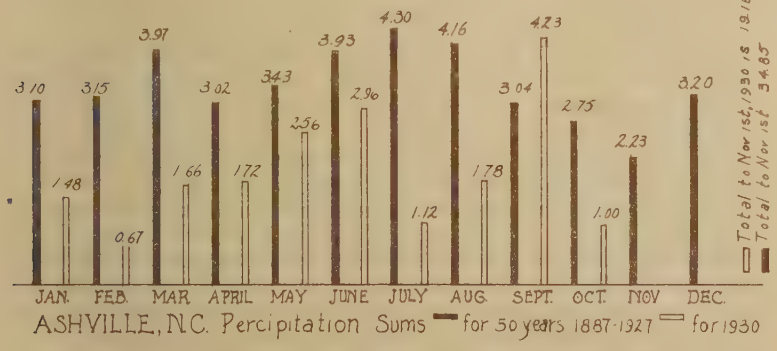
This study was started this spring with five three-acre plats; three with complete fertilizer, one basic and one check plat. The sod in these plats, with the exception of Plat 4, is in excellent condition. Due to very unusual moisture conditions the amount of grazing on these plats was limited during July and August.

The following table shows the plant food per acre for each plat:

		N	P_2O_5	K_2O
Plat 1		24	48	24 applied
Plat 2		24	48	24 applied
		15		applied a top dressing
Plat 3	Check			
Plat 4	Basic		48	24
Plat 5		24	48	24
		15		Top dressing
		15		Top dressing

Asst. Director S. C. Clapp and Dairyman Harry Coulter have put forth untiring efforts in starting and properly executing this project and no small amount of credit is due them.

This is a coöperative project with P. H. Kime of the Agronomy Division.



COASTAL PLAINS BRANCH STATION

The herd development work at this Station is being continued. The yearly average production for 1929 was 346.49 pounds of butterfat per cow.

Three official records were completed during the year and five cows are on official test at the present time.

SUMMARY OF DAIRY REFRIGERATION STUDIES

September 6, 1930

The data taken at this Station shows a much greater efficiency in mechanical refreigeration than by the use of ice. The milk is shipped a distance of 40 miles by rail to a milk plant. The local Board of Health's bacterial count of this milk at time of arrival at plant averaged 64,000 per cc. previous to the installation of the mechanical unit or when ice was used. In 1927, after the installation of this unit, the bacterial count dropped to 21,000 per cc.; during 1928 it was 14,000 per cc., and during 1929, 17,700 per cc. In addition, mechanical refrigeration required less work in handling, was more sanitary, gave a drier storage, and a lower temperature, which could be controlled.

	1925		1926		1927	1928	1929
	Ice	Cost	Ice	Cost	Cost per Current KWH @4c	Cost per Current KWH @4c	Cost per Current KWH @4c
Cost of Ice as compared to current	43,600	$218.00	40,400	$202.00	2418 KWH $96.72	2381 KWH $95.24	2839 KWH $113.56
Average Bacterial Count	55,200 per c. c.		64,000 per c. c.		21,000 per c. c.	14,000 per c. c.	17,700 per c. c.

The above cost data compare expenditures for ice and current but do not take into consideration charges to depreciation, interest, or service.

This project is conducted in cooperation with W. L. Clevenger, of the Dairy Manufacturing Section.

THE VALUE OF FLY REPELLANTS IN MAINTAINING SUMMER MILK PRODUCTION

The study is a continuation of some work conducted in 1927 to determine the efficiency of fly repellants as measured by the effect of their use in milk production.

In this trial the spray used was one sold with conservative recommendations as to value in increasing milk production.

This season has been unfavorable for fly breeding and the fly problem was not as great as usual. Daily observations in pasture did not show a marked difference in number of flies on the sprayed and unsprayed groups. When the two groups were placed in the barn to be milked the unsprayed group were covered with approximately six times as many flies as the sprayed group.

This project will be continued for two more trials.

The sprayed group showed a very slight increase in milk over the unsprayed group.

R. H. RUFFNER,
Head, Animal Husbandry.

RESEARCH IN BOTANY

DIVISION OF PLANT PATHOLOGY

S. G. LEHMAN, in Charge

Tobacco Mosiac. This disease causes large annual losses to the North Carolina tobacco grower. The losses are not so obvious as with certain other diseases to tobacco; nevertheless, they are very real. Tobacco plants having this disease are not killed outright, but suffer such losses in weight and quality of the cured leaf as to reduce the gross value of the crop by as much as 50 and 60 per cent in cases where the disease starts early and occurs on all the plants. Several such extreme cases and a great many of a less degree of severity were seen during the 1930 growing season.

A number of field and greenhouse tests have been made for the purpose of collecting facts which may have a bearing on control of this disease. Some of the conclusions drawn from the tests thus far made are as follows:

(1) The virus of tobacco mosaic is usually not destroyed in the process of flue curing. Tests made of diseased leaves taken from barns at the end of the curing period show the virus to be alive in some of the leaves and still capable of producing disease in growing plants. For this reason care should be taken to prevent tobacco refuse, even though it has passed through the heat of the curing barn, from coming in contact with young tobacco plants. In tests simulating the tobacco curing process, but run in an incubator in the laboratory, little or no inactivation of the virus resulted in leaves thoroughly dried by gradually raising the temperature to 158 degrees F. and holding it there for 47 hours. Raising the temperature and holding it at 142 degrees F. for 3½ hours, then at 190.4 degrees F. for 19 hours, reduced but did not completely destroy the ability of the virus to produce disease.

(2) The virus of mosaic is present in the small rootlets of diseased plants as well as in the leaves. It is apparently present also in the soil about the roots of mosaic plants. This is indicated by a test in which soil collected from beneath the roots of living mosiac tobacco plants was screened and potted. Six out of 10 plants in this soil became infected, while check plants set in uninfested soil remained free of disease.

(3) The mosaic virus was still alive after 4 months in soil which had been inoculated by adding juice pressed from fresh diseased leaves. Following inoculation the soil was stored in 10 one-gallon jars and kept at a moisture content suitable for good plant growth.

(4) A large number of diseased tobacco plants of the 1929 crop which had stood in the field over winter were examined the following spring (April 22). On about one per cent of the plants the roots were found to be in a semi-living condition. The tissues were turgid, succulent, just beginning to turn brown, but not black and decayed as was the case with roots obviously dead. In many cases a part of the root system was showing the semi-living condition while the remainder was dead and blackened by decay. It is doubtful if these live or semi-live roots could have formed suckers, but their condition was strong indication that the mosaic virus was still alive in them. When young tobacco plants were inoculated with juice pressed from these roots a high per cent of them developed mosaic. The mosaic disease also developed

on plants inoculated with juice pressed from dead roots, but in this case the per cent of disease was comparatively low. Where tobacco follows tobacco without an intervening crop it will be better to plow up and cut the roots into the soil as soon as the tobacco crop is off. This will promote their early death and decay, bring about the more rapid depletion of the mosaic virus in the soil, and reduce the chances of disease appearing in the succeeding crop. This conclusion is corroborated by the result of a test conducted at Raleigh in a field which had 100 per cent of mosaic in 1929. In this test 4 per cent of mosaic occurred on a plot where the stalks and roots stood over winter and were plowed into the ground in the spring. On other plots of the same test mosaic occurred as follows: Less than 0.4 per cent where the stalks and roots were cut into the soil in the fall, less than 0.7 per cent where stalks and roots were removed from the land in the fall, and less than 0.7 per cent where the stalks and roots were removed from the land in the spring. The plants set in this field came from a mosaic free bed and great precautions were taken to prevent infection of these plants in the operations of transplanting and cultivating. It is believed that the disease which did occur entered the plants by contact with the soil or with old, diseased plant materials in the soil.

The growth of a single crop of tobacco highly diseased with mosaic does not necessarily mean that the soil of that field has become highly infested. This is shown by the test just described. No tobacco had grown on this land previous to 1929. This crop was inoculated artificially so that 100 per cent of mosaic occurred. In 1930 not over 4 per cent of mosaic occurred on any plot. Considerably more than this would have been expected had a high degree of soil infestation occurred.

Passage of the virus of mosaic from the soil into the roots of tobacco plants apparently occurs through wounds. Tobacco plants growing in pots with their roots spreading among leaf, stem and root material taken from mosaic plants overwintered in the field did not become infected although they were allowed to grow until ready to bloom. At the conclusion of the test the mosaic virus was still alive in the old root and leaf material originally placed in the pots. At the time of starting this test the soil used in the pots was passed through a screen to remove all but the smallest insects. The soil was not disturbed from the time the plants were set until the end of the test. In the field there is, of course, abundant opportunity for root wounding in the activity of soil inhabiting insects and in cultivation.

The exercise of special care to prevent accidental inoculation of tobacco plants in the operation of transplanting is a highly important precaution in the control of tobacco mosaic. This is illustrated in Table I, which gives the per cent of mosaic which developed in several lots of plants handled in different ways at transplanting time. The use of snuff by workmen in pulling plants (Lot 2) from mosaic free beds resulted in considerable mosaic in the field by topping time, while plants (Lot 1) pulled by workmen not using tobacco developed little mosaic. A very high percentage of mosaic developed on the plants (Lot 3) which had been pulled while occasionally dipping the hands into a tea made from dry diseased tobacco leaves. When plants which had been handled with mosaic infested hands were dipped in lime water (Lot 4) considerably less mosaic developed than on undipped plants. However, the plants were so badly injured that the treatment cannot be recommeded.

TABLE 1

SHOWING THE RELATION BETWEEN THE METHOD OF HANDLING TOBACCO PLANTS AT PULLING TIME AND THE OCCURRENCE OF MOSAIC IN THE FIELD

Lot No.	How Plants were Handled at Time of Pulling from the Bed	Per Cent of Mosaic Occurring in the Field	
		27 Days	56 Days
1	Hands washed before pulling plants	0	4.9
2	Workmen chewing snuff and occasionally spitting on hands	3	13.1
3	Hands dipped occasionally in a tea made from diseased tobacco leaves	51.1	78.8
4	Same as Lot 3 but plants dipped in lime water after pulling	18.9	44.8
5	Plants dipped directly into a tea made from diseased tobacco leaves	82.3	99.3

Resetting plants in the exact place from which mosaic plants had been removed resulted in a high percentage of disease in the resets. Out of 80 plants reset in this manner 36.2 per cent developed mosaic within 30 days. Only 3.6 per cent of 96 plants reset in places from which no mosaic plants had been removed became diseased.

The operation of cultivating spreads mosaic extensively after the plants have reached such a size that the leaves rub the traces as the plow passes. This is indicated by a test in which a three row plat of healthy plants was located between two other plats set to inoculated plants. The results of this test are given in Table II. The 43.6 per cent of mosaic occurring on Plot 2 at the end of 55 days (topping time) was carried to it from adjoining plots in the operations of cultivating and hoeing.

TABLE 2

SHOWING SPREAD OF MOSAIC FROM DISEASED PLOTS TO AN ADJOINING HEALTHY PLOT

Plot No.	Treatment of Plants at Setting Time	Per Cent of Mosaic at Different Times After Setting		
		21 Days	27 Days	55 Days
1	Plants inoculated	66.7	85.8	100
2	Plants not inoculated healthy	0	0	43.6
3	Plants inoculated	32 5		98.6

In two tests adults of the white fly (*Trialeurodes vaporariorum*) common in greenhouses were transferred to young tobacco plants after they had been feeding for some time on mosaic plants. In a similar test tobacco flea beetles (*Epitrix sp.*) were used. Neither insect transmitted mosaic from diseased

to healthy plants. The beetles ate one or more large holes in leaves of all the plants to which they had been transferred.

Tobacco Seed Bed Survey. In coöperation with the office of Mycology and Plant Disease Survey of the United States Department of Agriculture a large number of tobacco seed beds were surveyed in the past spring by G. W. Fant and the writer. A report summarizing the results of this survey was published in the Plant Disease Reporter, Volume 14, page 98-100, under date of June 15, 1930. A survey of field diseases was also made in a number of eastern counties of the State. A report of this survey is being prepared for publication.

Cotton Seed Treatments. Cotton seed treatment tests were made again this year. Thirty-four different materials or combinations of materials were used. The very dry soil conditions which prevailed during the 1930 planting season operated to render differences between treated and untreated seed generally less striking than those obtained last year. However, Ceresan and certain allied dusting materials gave material increases in number of seedlings and improved the uniformity of stand. These improvements were more pronounced on cotton planted medium early than on cotton planted late. Table III gives results of a test at Raleigh in which dusted and undusted seed were compared at different rates of seeding. When planted at the same rate per acre the dusted seed gave better stands than undusted seed. In general, the differences were such that 1½ bushels of dusted seed produced as good a stand of seedlings as 2 bushels of undusted seed. One-half bushel or more

TABLE 3

Cotton Seed Treatment Test Central Station Farm, Raleigh—Summer 1930
Showing (1) effect of seed treatment on stand of seedlings and (2) the possibility of saving seed by dusting before plants

Seed Treatment	Rate of Seeding Bushels Per Acre	Number Seedlings Per 100-Foot Row[1]	
		Seed Planted—April 16	Seed Planted—May 2
None	2	274	387
Dusted	1	181	245
Dusted	1½	340	338
Dusted	2	431	513
None	2	270	363
Dusted	1	238	259
Dusted	1½	341	365
Dusted	2	490	404
None	2	286	336

[1]The numbers given are averages of three 100-foot rows. Count made June 4.

of seed per acre could have seen saved by dusting. In fact in this test one bushel of dusted seed per acre gave sufficient plants for a complete stand.

Delinted seed planted at Raleigh on April 16 gave a poorer stand than undelinted seed. However, delinted seed dusted with Ceresan produced a better stand of seedlings than undusted, undelinted seed. Delinted seed planted May 2, when the soil was drier and probably also warmer than on the earlier planting date, produced more seedlings per foot of row than undelinted seed. Dusted, delinted seed planted at this date gave a somewhat better stand than undusted, delinted seed. Delinted seed planted in a thoroughly warm and very dry soil came up much more promptly than undelinted seed.

The 1930 crop has not been picked at the time of this writing. In the harvested crop of 1929, increases as high as 294 pounds seed cotton per acre were obtained by dusting.

Cereal Smuts. The oat smut control work was continued, using 18 different treatments. Rod row plantings were made at several times in the period extending from October to March. Dry formaldehype, Smuttox, Ceresan, and Corona Oat Dust (Improved) gave very good control of loose smut. None of the four preparations used above caused marked seed injury in the season just past.

Two covered smut tests with wheat were put in coöperatively with workers of the United States Department of Agriculture. One of these was a test of covered smut control by use of chemical dusts. The other was a test of the resistance of certain wheat varieties to covered smut collected in different regions of Eastern United States.

Wheat Rust. This project is coöperative between the Departments of Botany and Agronomy of this Station and the United States Department of Agriculture. Numerous varieties and selections are being tested for yield and notes are being taken relative to resistance to leaf and stem rust. A number of head selections have been made from North Carolina grown Leaps, Purplestraw, and Fulcaster. None of these have proved to be strikingly resistant to leaf rust.

Soybean Diseases. A number of seed treatments were made for control of frogeye. These seed were planted under closed muslin cages to prevent infection from wind blown spores of the causal organism. The seed were planted late and the final notes have not been taken at this time.

PLANT DISEASE STUDIES

R. F. Poole, in Charge

Peach Bacteriosis Control Studies. A project was begun in 1929 having for its purpose a detailed study of the bacterial disease of the leaf, twig and fruit of peaches and plums because of the heavy loss caused by this disease in the commercial areas, especially to the marketable value of the fruit. In studying a problem of this type it seems advisable that the greatest amount of attention should be given to the causal organism, especially as to how it lives over from one year to another, how is it affected by seasons, how spread in an orchard, and what chemicals inhibit its growth. The results of these studies may readily be used in the practical control of the organism, *Bacterium pruni*.

Cankers obtained from Abundance plums and from peaches produced pure cultures of the organisms throughout the winter. The organisms were well protected in pockets near the pith of the twigs. In studying the cankers on both peach and plum during the season of 1929, it was quickly determined that they were so abundant that they could not be entirely removed by the pruning processes, which are now about as heavy as is advisable. Cankers on the plum were so numerous that most of the bearing wood would be removed were attempt made to remove the infected or live cankers. The cankers were not as abundant on the peach, but extremely heavy pruning would be necessary to get all cankers. In orchards where the cankering is not severe, these studies indicate that much of the cankered wood can be removed without

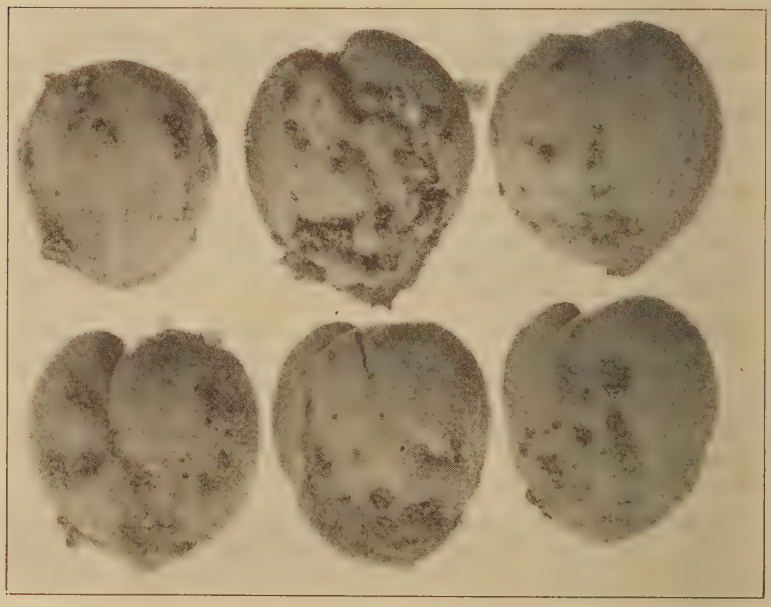


Fig. 1.—*Bacterium pruni* infection of Elberta peaches in which heavy excretions of gum were abundant this year.

seriously interfering with the maintenance of sufficient bud producing wood, but conclusions of canker removal as a means of control could not be prepared from these studies.

The conditions were favorable for greater wood growth this year than for the past three years. There was a heavy production of foliage and fruit in most orchards. Infection was greatly suppressed as compared to amounts observed during the two previous years when the greatest amount of infection was observed on the fruit on the highest branches that was exposed to a southwestern exposure. This year, infection was most noticeable well to the inside of the tree on water shoots somewhat protected by heavy foliage. The first fruit infection was most severe in the vicinities of cankers.

The spreading activities of the organism were not clearly defined. Peaches borne on branches below on the same level and above cankers were infected, mostly uniformly. In many instances peaches on the same spur showed greater infection than others. The symptoms of infection were quite variable on the peach. Some showing a dry, corky, scab effect, other spots being watery with unbroken tissue. Gummosis was especially prominent on all types of spots (see figure 1).

Leaf infection was first observed the latter part of May, one month later than the first fruit infection. Defoliation was not nearly as severe at any time during July and August as for the same period during the past two years. Trees on outer edges of orchards showed more defoliation than those some distance in the orchard.

All commercial varieties grown in this area were attacked, but some were much more resistant than others. Hiley Bells, Georgia Bells, Greensboro, Mayflower, Carmen, Early Rose, and seedling varieties were only slightly attacked. The early Elberta was more resistant than the strain maturing two weeks later. The Hale variety was most severely infected of all varieties.

Trees disease with crowl gall, caused by *Bacterium tumefaciens;* roo knot, caused by *Heterodera radicicola;* and root rot, caused by *Armillaria mellea,* were very prominent during the year, more so than in other recent years. Studies of bacteriosis infection on these trees in comparison with infection on healthy trees showed greater fruit and leaf infection on the trees that were not affected with the root diseases. Spots on both leaf and fruit of trees affected with the root diseases were somewhat similar to those caused by bacteria, but were diagnosed as physiological, since the *Bacterium pruni* did not develop in the tissues. Arsenic spray was not more severa on weakened trees, but the effects were more pronounced as to spotting and defoliation than on trees that were not affected with the root diseases.

A large number of chemicals were tested on peach foliage during the summer of 1929. Various strengths and combinations were used. During these studies some results were obtained on strengths of chemicals that could be applied safely to the foliage. The copper compounds, among others, were discarded, because of the complete defoliation obtained with any strength. In these tests the leaves turned yellow about three weeks after the copper compounds were used in both dust and liquid form. Defoliation was complete after six weeks. Manganese sulfate 1-1000 and zinc sulfate 1-1000 caused severe injury to both leaf and foliage when used without lime. Ferrous sulfate 1-1000 caused severe leaf spotting, but only slight defoliation. Calcium sulfate up to 20 pounds to 50 gallons of water did not injure the plants. Heavy applications of collodial sulfur, finishing lime, potassium permanganate 1-500, emulsified cresol 1-200, emulsified phenol 1-200 and others caused no injury. These were used in 1930 as a basis for spray control experiments.

Tests were conducted in four orchards. The Hale variety was used in the tests on the R. W. King orchard at Raleigh. The Elberta variety was used on the Evans farm at Fayetteville, Pate orchard at Laurel Hill, and Donaldson orchard at West End. The number of applications were five on the King orchard and six on the other three. The amount applied was two gallons per tree. The results show some reduction as compared with checks of all substances used, including zinc sulfate with lime and calcium caseinate 8-8-50.

5-4-50, 8-4-50, 5-3-50, and 4-4-50 strengths, collodial sulfur five pounds to fifty gallons, potassium permanganate 1-1000, emulsified cresol 1200, emulsified phenol 1-200 and finishing lime twenty pounds to fifty gallons. Further tests with these same materials will be continued, since combinations of such compounds as colloidal sulfur at the rate of five pounds to fifty gallons of water with emulsified cresol and phenol compounds at the rate of one to two hundred showed promising reduction of infection. It will be necessary to conduct further tests in years more favorable to the development of bacteriosis before conclusions can be drawn.

Tobacco and Tomato Wilt Studies. The wilts caused by *Bacterium solanacearum* were more severe during the past summer than during the two previous years. The high temperatures prevailing during the summer months seem to be associated with the greater losses for both tomatoes and tobacco. The disease of tobacco, called Granville wilt, was found in many parts of the State, but continues to be more severe in the Granville and Durham series of soils. The prevalence of the fungus wilt caused by *Fusarium lycopersici* was also observed throughout the State and frequently appeared in the same fields with the bacterial wilt.

Fig 2.—*Bacterium solanacearum*. Infection first occured on long roots near the ends. The organism worked through the conductive vessels to the stem and then outwards into the roots.

Cultures of the causal organisms of these two diseases were isolated and purified during the year. A sweet potato decoction medium of 250 grams sweet potato in a liter of water was found to grow both organisms very satis-

factorily. This medium is being used for studying the effects of chemicals on inhibiting fungus growth in order to establish the toxic ones.

Field tests were conducted with tobacco and tomatoes in areas where *Bacterium solanacearum* had previously caused heavy loss. The tests were made with various chemicals, which were applied to the roots and stems just before transplanting into the field. Zinc sulfate and lime 50-50-50, hydroxymercurichlorophenol 1-5, 1-10, and 1-20, copper carbonate 18 per cent, Bordeaux mixture 20-20-50 and 4-4-50, collodial sulfur 5-50, ground sulfur as a heavy dust, and lime as a heavy dust were applied to the roots and stems. The results showed that Bordeaux mixture, the zinc sulfate plus lime mixture,

Fig. 3.—*Phytophthora nicotianae.* Breda de Haan, causing black shank reported from Forsyth and Stokes counties, where the spreading activities of the fungus have become alarming. The symptoms from a distance are very similar to the Granville wilt caused by *Bacterium solanacearum*, which is the cause of heavy annual losses of tobacco in counties nearby.

hydroxymercurichlorophenol and sulphur all delayed infection slightly, but none gave satisfactory control, due to infection occurring mostly in the roots some distance from the stem and those parts of the root system and stem treated during the transplanting season. These studies clearly show that plant treatment alone will not solve the control problem, because the lateral roots frequently become infected ten inches away from the stem (figure 2) and since the organism works rapidly in the vascular bundles, it readily reaches the stem without coming in contact with the chemicals placed on roots and stems when transplanted.

Tests conducted with soil treatment brought out a possible practical approach to the control of the disease. The hydrogen-ion reaction in the area of the

root system was adjusted to pH 4.0 and pH 5.0. This reaction reduced infection 75 per cent in an area where the untreated checks showed 100 per cent killed plants. Plants died on the check plots at an early date, but plants killed on the treated plots reached maturity in nearly every instance before infection was observed. It will be necessary that this treatment be repeated on various soils and over a period of years before the necessary details can be finished on the value of the high acid reaction as a means of developing a practical control.

Plants treated with sulfur and set in soils infected with *Thielavia basicola* showed that a sufficiently high hydrogen-ion reaction was not obtained immediately after transplanting to completely arrest the disease, but some reduction in infection was obtained in these studies. The sulfured plants

Fig. 4.—*Leptostheria conisthyrium* can blight of dewberries. Fungus first attacked spurs and worked downwards into tissues below new canes causing them to wilt just before the berries were ripened.

recovered and grew more rapidly than the untreated plants, indicating that a high acid medium combined with sulfur may give a more definite control.

The black shank disease (figure 3) caused by *Phytophthora nicatianae* was found to be causing loss in fields in Forsyth and Stokes counties. It is spreading rapidly, aided by water, plows, tools, and shoes. Evidence on the history of the disease in this area obtained from County Agent Pou and growers indicate that it was first observed about 1910.

Dewberry Disease Control. Further studies on the control of *Leptosphaeria coniothyrium* by cutting all canes below the soil showed that a reduction of the losses from this organism is readily obtained by this practice. The results show that the plants cut at the soil line did not affect the yield of bearing canes, but plants cut from one to three inches below the soil greatly suppressed the

formation of bearing canes, although a complete control of the disease was obtained. Where the pruning was made 10 to 12 inches above the soil, the disease caused much injury, since many canes died when the organism attacked the old canes below the point where the new canes developed from the old ones (figure 4). When old canes were cut below the surface new canes developed and these remained healthy throughout the season. The canes that wilted because of the disease always produced berries that were premature. The inferior berries were most pronounced near the end of the harvest period.

Further studies and observations in fields located in the sand hills of Moore, Richmond, and Scotland counties clearly indicate that the causal organism of the cane blight confines its activities to those parts above the soil. The disease was found on canes three and four feet above the soil, but the greatest amount of infection occurred just above the soil. The evidence concerning natural infection indicates that the fungus begins as a saprophyte on the spurs left after pruning. It works into the live tissues slowly.

Plantings in which the canes were cut below ground after harvest from the beginning continue to show less infection than those where canes were cut above ground. Cutting the canes above ground any year was found to be favorable for heavy infection.

Prevention of Field Infection of Sweet Potatoes. Under this project the investigation of plant treatment with chemicals for the control of scruf, soil stain, rust, or mottle caused by *Monilochaetes infuscans* was undertaken. A large number of chemicals were used in these studies, but the preliminary results with organic mercury and sulfur compounds which were reported in the Fifty-second Annual Report suggested a concentrated study of these compounds on both plant and fungus, which were conducted in the laboratory and field.

Tests were conducted on farms in different parts of the State, and on several soil types, including Congaree silt loam, Cecil sandy loam, Durham sandy loam, Norfolk sandy loam, and Granville sandy loam. Diseased plants were used in all tests. These were readly grown from diseased potatoes. The plantings and cultural phases were the same as that followed by growers for the crop in the locality. The Nancy Hall, Porto Rico, and Yellow Jersey varieties were used.

When ground sulfur was dusted on roots and stems of diseased plants just before transplanting the disease was controlled on all soil types. The diseased tissues of treated plants were sloughed off, and both stem and potatoes were healthy at harvest. The control was obtained because the sulfur oxidized to sulphuric acid on the diseased parts, and the acid reaction killed the fungus before it could spread to the potatoes. The reaction was as high as pH 3.0 on some stems without causing damage. Yields were not affected, because check plants that were not sulfured produced equally as well as sulfured plants. The average results from the sulfur treatment in tests on all farms gave 5 per cent potatoes badly diseased, 10 per cent slightly diseased, and 85 per cent healthy for sulfured plants (figure 5), in comparison with 43 per cent badly diseased or completely blackened, 44 per cent slightly diseased and only 13 per cent healthy for plants which were not sulfured (figure 6). These results are published in Technical Bulletin Number 38, under the title of "A Chemical Control of Sweet Potato Scurf." A popular bulletin Number 274,

on "A Control for Sweet Potato Scurf," was also published during the year. Bulletin Number 273 on "A Control for Sweet Potato Wilt or Stem Rot," in which the data given was obtained from studies of this project was also published. Other results from studies on this project were published in the Fifty-second Annual Report.

Sweet Potato Disinfection Studies. After conducting an exhaustive study of treating scurfed sweet potatoes with various compounds of different strengths and used for various periods of treatment, conclusions are obtained that suggest that seed treatment cannot be lied upon to effect a practical control. The chemicals used did not penetrate the periderm sufficiently well to destroy the fungus, which was found imbedded in the form of sclerotial bodies intracellularly arranged. Partial control was obtained, but the long period of growing the plants was later found to be favorable for the organisms to reinfect much of the surface, and contamination was also found to be a serious problem to contend with when somplete control was not obtained.

These studies indicate that a 1-1000 mercuric chloride treatment for 15 minutes or a 10 per cent hydroxymercurichlorophenol solution of 1-10 strength are the most effective treatments, considering injury to sprouting caused by stronger solutions and other effective compounds.

A complete report of these studies and conclusions are published in Technical Bulletin Number 38.

Seed treatment studies on the control of the black rot disease, caused by *Ceratostomella fimbriatum* were started. Copper compounds including 20 per cent copper carbonate used as a dust, copper acetate 1-100, and Bordeaux mixture 20-20-50 were found to be very effective in inhibiting infection. Formaldehyde 1-100 strength also gave promising reduction of infection, but the results obtained with the mercury compounds were not as encouraging.

Sweet Potato Storage Studies. Further observations were made on sweet potatoes produced in storage and transit. Black rot caused by *Ceratostomella fimbriatum* was found to continue as the most destructive disease in storage and soft rot caused by *Rhizopus nigricans* was most severe in transit and rehandled potatoes after harvest, and especially during the shipping period in the early part of the year. A brown rot due to a *Sclerotinia species* caused some loss in both banks and storage during the latter part of the storage period. Other rots were observed, but were of no serius economic importance.

Inoculation studies were conducted with the black rot organism just before storing for the purpose of verifying the observations reported last year, when the disease was found to develop soon after storage, indicating that the spores were spread during harvest and storage. The laboratory studies showed that infection was very great following spore dissemination during harvest, and that the development of the disease was rapid during the first few days after storage. This explains in part the inefficiency of the present methods of curing on the control of this disease in the various methods of storage.

Much progress was made in these studies by developing a method for increasing the spore inoculum, which was not readily obtained in test tube cultures. Raw potatoes were sliced into cross section, rinsed well in sterile water, inoculated with a pure culture of the organism, and maintained in moist chambers at room temperature. Conidia spores developed abundantly

over the surface. These proved to be very satisfactory for inoculation purposes, giving more uniform infection than ascospores. Since high moisture content is necessary for satisfactory infection, the moist chambers were used for determining the effect of many chemicals on inhibiting infection and controlling the fungus. This procedure eliminated those compounds, of little or no control value, that would otherwise require much time if the practice of seed treatment was carried out with them.

The formaldehyde and copper compounds of the many compounds used were found to be most effective in inhibiting infection of *Ceratostomella fimbriatum*. Potatoes inoculated and then treated with these chemicals showed that practical control is possible with weak solutions of the above compounds.

Studies on Limiting Factors of Fungus Growth. When *Monilochaetes infuscans*, *Rhizopus nigricans*, *Ceratostomella fimbriatum* and *Fusarium batatatis* causal organisms of scurf, soft rot, black rot, and stem rot, respectively, were grown on media prepared from plant decoctions and synthetically there was no difference observed in the ability of the fungi to attack the potato. Excellent microconidia of *Fusarium batatatis* were obtained on sweet potato decoction of 250 grams in a liter of water with agar added. These microconidia were best suited for inoculation studies. *Monilochaetes infuscans* produced an abundance of spores on the same medium either with and without agar, when the hydrogen-ion range was between pH 5.0 and pH 7.0.

Studies on soil types as to the prevalence of diseases of the sweet potato indicate that there is a definite relation of the soil type to the presence of the organism. The stem rot, or wilt of sweet potatoes, causes heavy loss on Norfolk Sassafras, Granville, Durham and Cecil sandy soils, but is of no importance on heavier types of soils. When plants of susceptible varieties are inoculated with the causal organisms and transplanted in clay and rich loams the disease develops just as severely as on the sandy soils. When susceptible plants were transplanted in soils of these types twelve months after inoculating the soil, wilt or stem rot occurred only in the light sandy soils. This indicates that the heavy soils may not be favorable for maintaining the life of this particular fungus.

Studies on the Causal Organisms of Sweet Potato Disease. Further inoculations were made with *Fusarium batatatis* on Triumph, Red Brazil, White Yam, Yellow Yam, and Southern Queen varieties, which were resistant to infection in field tests. The Triumph and Red Brazil varieties continued to show resistance but were attacked during periods when the temperature reached 27 to 30 degrees Centigrade. These two varieties showed greater resistance to drought conditions than did other varieties.

Wilt or stem rot of sweet potatoes is found on light sandy soils where the Fusarial wilts of other crops are also most prevalent. Cultures of causal organisms of tomato, watermelon, cowpea, cabbage, cotton, and soybean wilts were isolated from these plants in areas near where the stem rot of sweet potatoes was found. When the Nancy Hall and Yellow Jersey varieties were inoculated with these organisms negative results of infection were obtained, indicating that the species of *Fusaria* attacking other crops in the same areas are distinct from *Fusarium batatatis*.

All studies with *Monilochaetes infuscans* and *Ceratostomella fimbriatum* indicate that the sweet potato is the only host of these parasites in this area.

PLANT PHYSIOLOGY

D. B. ANDERSON

1. Studies were made to determine the influence of $CaSo_4$ dusts upon the transpiration rate of peanuts and other plants. The rate of transpiration was determined from dusted and undusted plants. The leaf areas of experimental plants and of controls was accurately measured and the rate per sq. dem. of leaf area in each case was calculated. Results were plotted in the form of curves with temperature, relative humidity, and standard evaporation also plotted. Results are not entirely complete, but indicate that dusting the leaves of plants with calcium sulfate has but little effect on the rate of water loss from the leaves.

2. Studies upon the structure of the upper epidermal cell wall of peanut plants were made. These studies revealed the presence of abundant crystals of calcium oxalate in the outer wall of the epidermal cells. Stomata are about equally abundant on the upper and lower leaf surfaces. The presence of such calcium oxalate crystals in the cell wall is evidence that calcium is not deficient in the leaves. It is probable that the calcium sulfate dust does not stimulate the plant thru the absorption of the calcium-ion by leaf tissues. The outer epidermal wall shows the presence of cutin, pectic compounds and cellulose.

3. Microchemical studies have been made upon the structure of the outer epidermal cell walls of several plants characteristic of the sand hills. These epidermal walls show no uniformity of structure. Layers of cutin, pectic compounds and cellulose occur in different positions and in different relationships to each other in the different epidermal walls. There seems to be no correlation between this plant habitat and epidermal cell wall structure.

B. W. WELLS,
Head, Department of Botany.

RESEARCH IN HOME ECONOMICS

Research in Home Economics was organized October 1, 1929. The purpose of this work is to conduct research which will furnish further information regarding how farm families live. The Division of Home Demonstration Work of the Extension Service is attempting to raise the standard of living of farm families, and is therefore particularly interested in securing data regarding living conditions and needs of farm families on which to plan future programs.

The Department of Research in Rural Sociology has previously made investigations of farm family living in Wake County. It has studied the relationships between income, size of farm, farming experience, size of family, production of food and fuel for family use, and schooling of farm operators, and their effect upon the proportion of food and fuel, clothing, personal items, advancement, home and household goods, automobile. The Department is now completing a study to analyze the influence of community factors and institutions on the determination of the proportion of the expenditures used for various elements of family living. As a further step in understanding and interpreting the conditions underlying farm family living in Wake County there was need for a detailed case study of a few successful farm owner families from the standpoint of family organization. It is this study that has been undertaken by the research workers in Home Economics.

The families have been selected in two ways. Some have been chosen from those included in one of the recent sociological surveys of Wake County mentioned above. Others were among those suggested by the county nurses, home demonstration agent, farm agent and school principals as being successful not only from the standpoint of farm and home management, but also that of happy family life. The families selected have children of school age or under. As a whole those families who have been approached have been interested and coöperative. Each family selected will be visited a minimum of eight times in order that the research workers may become well acquainted in the home.

This type of study is somewhat new in rural social research and must be tried out carefully step by step. It is hoped that through these case studies will come an analysis of underlying factors conditioning farm family living in Wake County.

MYRA DEHAVEN WOODRUFF,
Associate in Home Economics Research.

October 20, 1930.

RESEARCH IN HORTICULTURE

Commercial horticulture in North Carolina has made the greatest development in the Coastal Plain and Tide Water, the Mountains and in the Sandhills areas of the State. The Coastal Plain and Tide Water area is characterized by early Irish potato, sweet potato, strawberry and truck crops and is by far the largest and most important horticultural section. A conspicuous field floral industry is also developing in this area. The Mountain Section is characterized by the late Irish potato and apple crops, although truck and small fruit growing are becoming increasingly important. The Sandhills form that area in the south central portion of the State in which the peach, watermelon and dewberry are the outstanding crops. With the exception of the Sandhills and a few scattered counties of the Piedmont, where more or less isolated and individual efforts are proving highly successful, commercial horticulture is largely confined to the Coastal Plain and the Mountain sections of the State.

Commercial processing such as canning, cold packing and the like is of minor importance at the present time. Consequently with the exception of such crops as late Irish potatoes, sweet potatoes, late cabbage and apples which may be held in storage, the crops are marketed "fresh." The hazards of production and of marketing are greater, therefore, than if adequate means of disposing of surpluses existed. The department is studying the developments and problems arising from the canning, cold packing, quick freezing and pickling of fruits and vegetables in the light of the possible future development of such industries in the State. The immediate problems of the industry, so far as they relate to the activities of the Department of Horticulture, are, however, those of production and to a lesser degree storage, refrigeration, and transportation.

The problems of production arising as they do from so large and varied a group of crops as those in horticulture have almost infinite ramifications. Those receiving some attention by the Department of Horticulture and the more important methods of attack may be conveniently outlined without regard to crop and without particular regard to completeness as follows:

I. Crop improvement:
   - A. Tests of foreign seed and plant introductions.
   - B. Fruit, vegetable, flower and shrub variety tests.
   - C. Plant breeding investigations.
   - D. Introduction of new varieties.

II. Improving quality and yield per acre:
   - A. Rotation, succession and companion cropping, intercropping.
   - B. Soil improvement; fertilization, green manuring, cover cropping.
   - C. Pruning, thinning and harvesting.
   - D. Pollination and fruit setting.

III. Storage and transportation:
   - A. Factors affecting storage or canning quality.
   - B. Factors affecting quality at destination; i.e., refrigeration, precooling, quality at harvest, etc.

IV. The measurement and estimation of the factors influencing plant growth and reproduction:
Hardiness.
Fruit bud formation.
Yield and quality.
Moisture requirement.
Nutritive requirements.

Many of these problems have to do with field or orchard management, consequently solutions are to be sought largely in the sections where the crop and the problems are important. To this end the Department, in addition to carrying on active work at a number of the Branch Stations, is establishing various experiments and tests by coöperative arrangements with growers, where the results at the nearest Branch Stations would not seem directly applicable.

For a number of years such an arrangement has been in operation with Mr. J. P. Herring, at Wilmington, and is being enlarged and extended this year to carry on additional and more intensive work on strain and variety testing and fertilization of vegetables. Mr. James T. Albritton, Calypso, North Carolina, in one of the most important trucking counties, is coöperating with the Department in conducting an experiment with strawberries. There is no branch station at all comparable to the Sandhills, where the commercial peach area is found. Consequently for a period of years certain investigations with dewberries and peaches have been conducted by coöperative arrangements with growers in this section. We are especially indebted to Mr. Z. V. Pate, Laurel Hill, and to Mr. Von Canon, West End, Mr. Hurd, Pinehurst, and Mr. Derby, Jackson Springs. Recently the peach investigations dealing with fertilization, soil management and the physiological reactions of the tree under Sandhills conditions have been considerably extended through the coöperation of Mr. Richard Lovering, Jackson Springs, and through the coöperation of the U. S. D. A. Office of Horticultural Crops and Diseases. The Piedmont and Mountain Branch Station farms are located in horticultural sections, although climatic and soil factors are not always favorable for study of certain specific problems. It has become necessary to conduct certain phases of the potato improvement work at the higher altitude of Avery County and a phase of the apple fertilizer work in Surry County. Thus at the present time, in addition to the work being conducted at the Central Station and four of the branch stations, work is being conducted at five cooperative stations. With the exception of the northern coastal plain, experimental work has been established in all of the important producing centers of the State.

In addition to the more or less simple treatments of problems relating to production, certain problems are of such nature and importance as to require careful and detailed methods of analysis. Such a problem is the measurement and interpretation of factors influencing maturity, rest period and hardiness of the peach tree; the moisture and nutrient requirements of the tree to carry a crop of fruit of the desired quality, size and color; the effects of defoliation, size of crop, soil moisture, pruning, thinning and fertilization on growth and reproduction. Such a problem requires not only careful field measurements, but also through chemical and physical or other laboratory treatment. Find-

ings from such methods of attack should not only have important bearing on practical orchard management, but also would add to the growing fund of scientific knowledge of the physiology of crop plants. Another example will serve to illustrate the many methods of attack on the growers' problems. The yield and quality of white potatoes has not been materially improved in the last thirty years. Aside from frost, drouth, hail and other weather conditions, largely outside of human control, early and late blight and mosaic diseases are tremendous factors affecting yield. Considerable improvement in natural yielding ability is possible. The commercial types of potatoes have many vine or tuber defects that might be improved. All of these characters, disease resistance, yield and quality are heritable characteristics. The Department of Horticulture, in coöperation with the Office of Horticultural Crops and Diseases, is undertaking to combine these characteristics in one or more adapted varieties by plant breeding methods. Improved varieties would not only tend to reduce the costs of production, but would release a certain amount of land from annual production which could be used for other money or soil improvement crops.

Detailed reports of progress on these projects follow:

APPLE INVESTIGATIONS

Apple Pruning and Training, M. E. GARDNER, Leader.

Having been conducted for eleven years, this project is beginning to yield significant results.

The season of 1929 was not conducive to high yields due to the fact that frost and cold weather occurred during the blooming and pollinating periods. However, satisfactory yields were obtained as shown in the accompanying table.

EFFECT OF SEVERITY OF PRUNING ON YIELD

Variety	Average Yield in Bushels Per Tree		
	Light Pruning	Medium Pruning	Heavy Pruning
Delicious	3.57	1.60	.57
Rome	3.40	3.59	.79
Stayman Winesap	4.34	3.72	2.89
Winesap	7.78	7.63	3.23

There was much aphis injury on lightly pruned trees, particularly Winesap. This was probably due to both dense foliage and improper timing of sprays. The trees have maintained uniform vigor and only one tree in the entire experiment has died. This was due to field mouse injury and was detected too late to remedy by bridge grafting.

Beginning in 1931, all fruit picked from the experimental plots will be carefully graded to determine the percentages of the various grades resulting

from pruning treatments. It is likely that with heavier yields the grade of fruit will become of considerable importance.

A summary of the eleven years results on this project is in process of preparation.

Apple Fertilization, M. E. GARDNER, Leader.

The status of this experiment is the same as last year. However, a careful check has been made of growth response as indicated by trunk measurements, but no very significant differences are apparent. This condition can probably be attributed to two causes: a naturally fertile soil, and the fact that the trees are young and have not as yet undergone severe strains in bearing heavy crops of fruit.

PEACH INVESTIGATIONS

Peach, Physiological Studies of Growth and Reproduction, C. F. WILLIAMS, I. D. JONES, J. H. BEAUMONT, Leaders.

Hardiness. The plots used from 1926-1929, primarily for the study of winter injury have been discontinued and replaced by a more complete experiment on nutrition in the peach. These new plots have received differential fertilizer treatments during the past season and records of growth, yield, etc., have been secured. Samples of representative trees from plots receiving different treatments have been collected at regular and critical periods for chemical analysis. These will be used in a study of the food reserves of the tree in relation to duration of rest period, winter injury, growth, and fruit setting.

Data on the older plots are now complete and are being tabulated and correlated. The results of this work will be presented elsewhere. In general, trees receiving nitrogen applications in addition to the regular fertilizer show greater percentages of total nitrogen and lesser percentages of the carbohydrate fractions throughout most of the year than trees receiving the regular fertilizer alone. This condition relative to carbohydrates is reversed in late winter and early spring, more starch and non-reducing sugars being present in the treated trees. This is correlated also with an increase in vegetative vigor in the spring. The growth and fruiting behavior of the trees has likewise been observed so that the chemical and growth relations can be correlated. Facilities have recently been provided whereby it will be possible in future work to determine the approximate hardiness of material by artificial freezing.

Nitrogen Assimilation. Preliminary studies on the absorption and assimilation of nitrogen have been made. Seedling peach trees grown in pots and held at different temperatures indicate that they will assimilate nitrogen during dormancy, if temperatures are above 40 degrees F. The seedling trees were treated with and without nitrate of soda, half of each treatment being held in the greenhouse. Samples were taken during January, 1930, and analyzed for amino nitrogen, organic and ammonia nitrogen, nitrate nitrogen and total insoluble nitrogen fractions. These studies will be cotinued for it would seem that root activity during the winter months in southern latitudes would be of considerable importance.

Peach, Factors Influencing Yield and Quality, J. H. BEAUMONT, C. F. WILLIAMS, M. E. GARDNER, Leaders.

Peach Fertilization in the Piedmont. As outlined in previous reports, this experiment was established to determine the effect of quickly available nitrogen on growth and fruiting of peach trees under Piedmont conditions. Nitrate of soda has been used as the source of nitrogen.

The trees receiving no fertilizer since planting have shown a steady, but gradual, decrease in vigor as indicated by short terminal growth and a lack of spur formation on the older wood. However, they have continued to produce reasonably well as will be shown by the accompanying table. The orchard is in its seventh growing season.

COMPARISON OF FERTILIZED AND UNFERTILIZED TREES

Variety	No Nitrogen Average Yield, Bushel—Per Tree			Nitrogen Two-Year Average, 1928–1929
	1928	1929	Two-Year Average	
Hiley	1.70	.60	1.15	3.37
Belle	2.00	.85	1.42	2.61
Elberta	1.65	1.30	1.47	3.12
Hale	1.75	.83	1.29	3.00
Augbert	.94	1.37	1.15	2.31

No. 1.—Georgia Belle which has received an annual and increased amount of nitrate of soda since planting. Same age as Nos. 2 and 3.

No. 2.—Seven year old Elberta tree which has received no fertilizer. Contrast tree condition with Hale. (No. 3.)

No. 3.—Seven year old Hale which has received no fertilizer.

It has been assumed in this work that nitrogen is the limiting factor in the Cecil clay soils of the Piedmont area. Apparently this is true. However, there is need for a more comprehensive study of the effect that nitrogen as well as other plant food elements have in the economic production of peaches in this region.

Peach Pruning. This experiment is now in its seventh season and is yielding some significant contrasts. As outlined in previous reports, the purpose of the work is to determine the effect of heavy and light pruning on tree performance under Piedmont conditions.

Trees receiving the heavy pruning treatment have been handled uniformly since the beginning of the experiment. Heavy thinning has been practiced together with the heading back of 50 per cent all new growth.

The last three years, an attempt has been made to determine, as nearly as possible, the best method of handling the trees receiving the light treatment. Indications are that uniform light pruning every other year is necessary. In 1927 and 1928 practically no pruning was done. In 1929 it was necessary to cut tops back into two and three year old wood and curb rangy branches. No tipping was done but centers were opened. Light pruning continues to give largest yields of fruit of good color and size at least pruning cost.

Peach Fertilization and Orchard Management in the Sandhills. This project was begun in 1930 with the coöperation of Mr. Richard Lovering, Hoffman, N. C. A block of 900 Elberta trees 8 years of age and apparently quite uniform in size and yielding ability was selected. The planting plan of this orchard made it possible to lay out 40 seven-tree blocks, which would eliminate most of the missing trees and mixed varieties. The blocks are surrounded on all sides by buffer rows. Trunk circumferences were taken and from these measurements the plots were paired in such a way that the average of each pair would be approximately equal to the average of all trees and still secure random soil distribution. The effect of time and rate of application of nitrate fertilizers is the major objective. The times of application are as follows: before bloom, June drop, after harvest, and as trees enter dormancy. The rate varies from a total of 1½ to 6 pounds of nitrate of soda per tree. The orchard is covercropped in alternate middles with vetch, which is fertilized with 300 pounds per acre of a complete fertilizer analyzing about 8 P_2O_5—3½ N 4 K_2O except on certain plots that did not receive P_2O_5, K_2O or both. The vetch may be given a light top dressing of Na No_3 in early spring.

Data on trunk circumference, date of maturity, yield, size and color of fruit, terminal growth, prunings and the like will be secured each year.

FRUIT VARIETY TESTS

Fruits. Several new varieties of grapes and peaches have been added to these tests. Also a number of varieties of Japanese persimmons have been budded on *Diospyros virginiana* stocks. Another shipment of plant materials has been received from the Office of Foreign Seed and Plant Introduction for test at the Central Station, and was planted on a very desirable plot of ground secured through the coöperation of the State Department of Agriculture.

Data are being collected on varietal adaptation and response of the various plants under test to the varying soil and climatic conditions existing in the State.

Strawberry. Over a four year period at the Mountain Station, Premier (Howard 17) and Warfield have given the highest yields of any of the seventeen varieties under test. A three year average gives Warfield 4,300 quarts per acre and Premier 3,600. This average includes yields recovered in 1926 when the drought caused adverse weather conditions. In 1928 Warfield produced 7,575 quarts and Premier 5,640 quarts per acre.

Both of these varieties are being recommended for Western North Carolina conditions. Warfield will not produce when planted alone due to the fact that it is pistillate, but when planted with Premier in alternate rows, it will fruit satisfactorily. Furthermore these two varieties have not been affected by seasonal fluctuation nearly so much as have most of the other varieties.

Blakemore (U. S. D. A. 659) has been added to the variety test and U. S. D. A. 655 will be added also.

FRUIT BREEDING

Dewberry Breeding. Of the 1927 crosses, two individuals of the Young by Austin spineless cross have been saved for further trial and use in breeding. One of these is spineless and the other almost so. Eight of the Young by Lucretia cross of the same year have also been saved for further observation and breeding. One of the best of these is almost spineless. Plants have been selected for resistance to cane and leaf diseases, yield, quality and firmness of fruit.

Crosses of Cumberland and Latham raspberry with the *Rubus corcanus* type have given many vigorous healthy plants. It is of interest to note that there is a considerable range in the character and number of spines, from very few to many. These crosses should fruit in 1931 and are being watched with interest.

During the 1930 season Young was selfed, crossed with Austin spineless, and with a spineless seedling of Young and Austin spineless. A quantity of seed was secured in the first two crosses, and a few in the third. Very little pollen was available of the spineless seedling due to cold injury to the canes the previous winter.

Peach Breeding. The objectives of this project are to secure peach varieties of the season or earlier than Elberta, resistant to "Bacteriosis" caused by *Bacterium pruni*, and having the desirable commercial characters of yield, vigor and shipping quality.

Observations have been made of the relative disease resistance of commercial varieties. It is planned to use resistant varieties in crosses with Elberta and in other combinations. The Yellow Elberta (which is probably Early Elberta) has proven to be disease resistant, is a trifle earlier than Elberta and is extremely vigorous and high yielding. Seed of this variety and of Elberta were saved from isolated trees in a commercial orchard where there was great likelihood of their having been either self or cross pollinated with the variety desired. The seedlings will be grown at Raleigh and transplanted in the Sandhills. It is hoped that weather conditions will be more favorable and that it will be possible to make large numbers of hand pollinations next year.

SMALL FRUIT INVESTIGATIONS

Dewberry, Factors Influencing Growth and Fruiting, C. F. WILLIAMS, Leader.

More work was done on the method and degree of pruning than other phases of this project during the past year. This is summarized in the following table:

PRODUCTION OF FRUITING CANES OF DEWBERRIES AS AFFECTED BY PRUNING IN DIFFERENT WAYS

Location	Treatment Pruned July 1, 1929	Average Number Canes Per Plant—March, 1930		
		Canes More than 3 Feet Long	Canes Shorter than 3 Feet	No. Dead Canes
Sandhills Station	All canes cut at the top of the crown.	1.6	5.8	0
	Mature canes cut at the surface of ground. Spring canes cut about 12 inches above the ground	7.2	3	3
Coastal Plains Station	Mature canes at ground level, spring canes unpruned	2.8	4.3	Several
	Mature canes at ground level, spring canes about 12-inch spurs	7.0	4.5	2
	Mature canes at ground level, spring canes at ground level	7.7	4.0	1.1

Canes were severely injured by cold during the winter of 1929-1930, which accounts somewhat for the large number of dead canes. In the Sandhills cutting the canes at the top of the crown greatly reduced the number of canes, but did reduce the number of diseased canes. At the Coastal Plains Station spring canes that were left for fruiting the following season were badly injured in handling during the summer of 1929 and the results indicate very little concerning this type of pruning. Yields of fruit were so severely affected by adverse conditions of drought that they are not included. Further tests including other treatments have been started this year.

No appreciable differences have been secured with fertilizer treatments.

Strawberry, Study of Yield and Quality as Affected by Different Fertilizers, R. SCHMIDT and J. H. BEAUMONT, Leaders.

The original plan of this project has been outlined in previous reports of this Department and of the Department of Agronomy. The project as outlined was discontinued following the crop season of 1930. However, the Department of Horticulture has expanded the strawberry investigations and has established an experimental plot on the farm of Mr. James T. Albritten, Calypso, North Carolina. (See cut.) This, therefore, constitutes the final report of the old project and the preliminary report of the new project.

Unfavorable weather during the past two years, an ununiform stand of plants, and irregularities in the field on which the experiment was laid out have made it extremely difficult to make accurate comparisons between the 28 different fertilizer treatments. In order to overcome certain of these dif-

ficulties each 1 20 acre plot was divided into 3 sub plots of 1 200 acre area, as nearly typical of the entire plot as possible. Each 1 200 acre plot was harvested separately. This has made it possible to compare adjacent plots with a greater degree of accuracy, although the probable error for the experiment as a whole cannot be determined.

Certain studies of yield, growth, estimated yield, grade and quality of the plants and fruit from these plots have been made. The coefficients of correlation between the more important characters have been calculated and are presented in the following table. In each instance the average of 3 sub plots of 1/200 acre area has been used.

RELATIONSHIPS BETWEEN YIELD AND FRUIT AND PLANT CHARACTERS

Yield 1929—Yield 1930	r =	.630	± .077
Yield 1929—Estimated yield 1929	r =	.745	± .067
Yield 1929—Estimated vigor 1929	r =	.937	± .016
Yield 1929—Grade of berries 1929	r =	.318	± .021

The correlation coefficient of measured yield of the same plots in successive years is not as large as might be expected and indicates that the yields have not been uniformly affected by the weather or other conditions, the time and amount of fertilizer application remaining constant. It would be unwise therefore to compare the yields of these plots on a basis of one or even two years yield records, assuming that the soil was uniform.

Strawberry experiment on the farm of Mr. James T. Albritten, Calypso, North Carolina.

Just before harvest in 1929 individual plant records of estimated number of berries or yield and relative vigor of individual plants were taken. The coefficients of correlation of these two characters with the actual yield in 1929 are the 2d and 3d coefficients given in the table. The first coefficient indicates that such a determination gives a fairly accurate estimate of yield, although it is subject to considerable error and is not to be recommended in place of actual yields. There seems to be a marked relationship between the size or vigor of plants, however, and actual yield. To all intents and purposes this character might be used instead of yield to estimate the difference between plots. The relation between total yield and grade of berries as measured by the percentage of berries at the height of the picking season, indicates that there is no strong tendency for high yielding plots to run to the larger sizes of berries.

Percentages of diseased and soft berries in samples from plots receiving extremes of fertilizer treatment and from which the greater differences in condition would most likely appear, are inconclusive. In almost every instance the variation in the three sub plots was as great or greater than the difference between any two plots receiving different treatment. It must be concluded, therefore, that the care exercised in picking is probably more important in influencing rot, disease and carrying quality than possible differences due to type and kind of fertilizer used. No differences in color or flavor were noted.

INVESTIGATIONS IN FLORICULTURE

Variety Tests with Floral Crops, G. O. RANDALL, Leader.

During the fall of 1928 and the spring of 1929 a series of variety tests was undertaken with the following outdoor-grown floral crops: roses, herbaceous perennials, tulips, narcissi and iris. The results of these tests, while not considered conclusive, indicate sufficient cause for preference of certain varieties. Notes have been taken on general adaptability of the different crops to local conditions. These include data on rate of growth or vigor, resistance to disease, and climatic adaptability. Following are the results obtained with the different crops under observation:

ROSES

No. Varieties in Test	*No. Showing Promise*	*Names of Those Showing Promise*
63	24	
		Dutchess of Wellington, H.T.*
		Mrs. W. C. Egan, H.T.
		Padre, H.T.
		Red Radiance, H.T.
		Pink Radiance, H.T.
		Chas. K. Douglas, H.T.
		Gruss an Teplitz, H. T.
		Miss Cynthia Forde, H.T.

* H.T. Abrev. for Hybrid Tea.

ROSES—*Continued*

No. Kinds in Test	*No. Showing Promise*	*Names of Those Showing Promise*
		Ideal, P.[1]
		Edith Cavell, P.
		Gruss an Aachen, P.
		Georg Arends, H.P.[2]
		Ulrich Brunner, H.P.
		Magna Charta, H.P.
		Henry Nevard, H.P.
		Pink Grootendorst, R[3]
		Rugosa, R.
		Agnes, R.
		Dr. Huey, C[4]
		Silver Moon, C
		Paul's Scarlet Climber
		Christine Wright, C.
		American Pillar, C.
		Dr. W. Van Fleet, C.
		PERENNIALS
86	35	
		Erysimum pulchellum
		Arenaria montana
		Sedum acre
		Cerastium tomentosum
		Gypsophila repens
		Dianthus caesius
		Dianthus deltoides
		Teucrium chamaedrys
		Veronica spicata
		Anthemis tinctoria
		Linum flavum
		Geranium sanguineum
		Statice latifolia
		Gaillardia grandiflora
		Aquilegia, long spurred hybrids
		Achillea ptarmica
		Pyrethrum roseum
		Stokesia cyanea
		Geum coccineum
		Salvia azurea grandiflora
		Achillea filipendulina
		Agrostemma coronaria
		Platycodon grandiflorum
		Physostegia virginiana
		Anchusa italica

[1] P. Abrev. for Polyantha.
[2] H.P. Abrev. for Hybrid Perpetual.
[3] R. Abrev. for Rugosa.
[4] C. Abrev. for Climber.

PERENNIALS—*Continued*

No. Varieties in Test	*No. Showing Promise*	*Names of Those Showing Promise*
		Lythrum roseum
		Coreopsis lanceolata
		Papaver orientale
		Eryngium planum
		Chrysanthemum maximum
		Digitalis gloxiniaeflora
		Helianthus rigidus
		Thermopsis caroliana
		Lathyrus latifolia
		Hibiscus moscheutos
		TULIPS
54	26	
		Early Single
		Kaiserkroon
		Prince of Austria
		Couleur Cardinal
		Roosvandekema
		Early Double
		Couronne D'or
		Schoonoord
		Darwin
		City of Haarlem
		The Bishop
		Homere
		Prince of Wales
		Herodiade
		Clara Butt
		President Harding
		Mr. Farncombe Sanders
		Pride of Haarlem
		Painted Lady
		Prince of the Netherlands
		Breeder
		Feu Ardent
		Wm. the Taciturn
		Bachus
		Annie McGregor
		Cottage
		Bouton D'or
		Inglescombe Yellow
		Pride of Inglescombe
		Dutch
		Belle Irlandaise

NARCISSI

No. Varieties in Test	*No. Showing Promise*	*Names of Those Showing Promise*
8	7	
		Van Waveren's Giant
		King Alfred
		Emperor
		Sir Watkins
		Grand Soleil d' Or
		Barri Conspicuous
		Poeticus ornatus

IRIS

19	10	
		Bearded
		De Neuilly
		Archeveque
		Germanica
		Kochi
		Beardless
		Gold Bond
		Koki-No-Iro
		Iphigenie
		Spanish
		Cajanus
		King of the Blues
		Reconnaissance

VARIETY TESTS WITH FLORAL CROPS UNDER GLASS

Many of the new varieties of roses and carnations were originated in the North and all of them were given their first trial there, where the climatic and growing conditions are quite different from those in North Carolina and other southern states. Variety tests and culture of the newer varieties of greenhouse roses and carnations in comparison with older standard varieties commonly grown in this section should be of value to the growers of the State.

With these objects in mind, tests of the following greenhouse varieties of roses and carnations were undertaken during the year as a part of the above project. Each year the newest varieties are to be added to the trial and those proving unsatisfactory in comparison with standard varieties will be discarded as quickly as possible.

ROSES

Five plants, standard stock, of each of the varieties of roses shown in the following table were included in the test:

AVERAGE YIELD PER PLANT—BY MONTHS

Variety	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	Total Aver.
Killarney	5.0	8.8	.6	6.6	5.4	1.2	7.2	8.0	1.6	44.4
Pernet	4.6	2.0	3.6	2.4	1.8	2.0	1.4	4.2	.4	22.4
J. Hill	4.4	1.6	3.0	3.2	1.6	2.6	1.4	4.6	1.6	24.0
L. M. Stewart	4.2	5.8	.6	2.0	1.8	1.6	2.6	4.2	.6	22.4
Talisman	4.8	5.0	2.2	6.2	2.8	2.4	6.4	6.0	1.2	37.0
Gaiety	2.8	5.0	.6	2.2	.6	2.0	2.6	3.0	.4	19.2
Rapture	3.2	4.0	1.2	3.4	1.4	2.2	4.6	3.6	3.6	27.0
Butterfly	5.0	4.0	1.4	3.6	1.2	2.8	4.6	4.4	2.2	28.8
D. E. Helen	2.2	3.4	.6	2.4	.8	.8	2.2	3.2		15.4
Rosehill	3.8	4.2	1.4	3.2	.6	2.0	3.8	2.6	1.2	22.8
Briarcliff	2.6	4.6	1.2	3.6	1.0	2.0	4.6	4.4	.8	24.8
Matchless	2.0	4.2	.2	4.0	1.8	2.4	5.6	3.6	2.6	26.0
Premier Sup	4.0	6.0	.8	4.2	1.4	2.8	4.6	4.2	3.0	31.0
Premier	4.8	4.0	1.2	4.4	1.6	3.2	4.4	4.8	2.0	30.0
Pierson	5.4	4.2	1.6	3.0	1.4	2.4	5.2	3.4	1.6	28.2
Templar	3.6	3.4	1.4	4.2	1.4	2.2	6.2	4.2	1.4	28.0
E. G. Hill	4.8	6.2	1.2	4.2	1.6	2.4	5.0	4.8	1.6	31.8

CARNATIONS

The minimum number of plants used for any one variety was fourteen.

VARIETY TEST OF CARNATIONS

Variety	No. Cut	Yield Per Plant	Average Length of Stem	Percentage Weak Stems	No. Splits
Betty Lou	182	6.2	19.49	3.8	6
Early Dawn	159	7.5	20.51	19.5	13
Fairy Queen	47	3.3	22.07	4.3	0
Hilda	156	11.7	15.98	8.9	0
Harvester	133	9.5	19.42	22.5	2
Ivory	106	7.5	19.47	10.4	8
Laddie	131	4.6	21.47	0.0	8
Maine Sunshine	106	7.5	20.02	31.1	4
North Star	91	6.5	18.17	10.9	1
Pink Abundance	114	8.1	18.27	0.0	1
Radiolite	99	4.9	22.12	1.0	0
Red Matchless	162	5.5	17.27	6.8	32
Sunglow	222	10.6	17.18	6.8	9
Spectrum	121	8.2	19.85	41.3	18
Senator	131	9.3	19.87	13.0	6
Ward	189	5.5	18.77	11.1	26
White Matchless	114	8.1	18.00	8.7	0

A comparison of the yields by months during the first year of roses and of the total yields of roses and carnations indicates that certain varieties are outstanding. Others are naturally poor yielders or perhaps they require special or detailed handling. A great deal of work needs to be done on the factors affecting growth and yield not only of greenhouse floral crops, but also of those grown outdoors.

VEGETABLE INVESTIGATIONS

Final Report of Field Plot Experiments and Observations on the Cause of Lettuce Tipburn, Robert Schmidt, Leader.

In 1924 a series of experimental plots were laid out to study the effects produced by different combinations of fertilizer on the growth and amount of tipburn of letture plants. The variety Big Boston was used and standard field cultural practices were followed. Results indicated that fertilizers have nothing to do with tipburn except as they affect the growth of the lettuce plant. The percentage of plants developing tipburn was approximately the same on all plots in which the treatments induced rapid growth and produced

Lettuce Plots

large heads of good quality, while on plots where the treatment retarded the growth of the plants to a marked degree very little tipburn occurred. For example, heavy applications of stable manure produced the largest heads of the best quality and a high percentage of tipburn, absence of phosphorus in the fertilizer resulted in sickly plants which produced very few heads, none of which developed tipburn, and absence of potash produced soft, unmarketable heads and very little tipburn.

In 1925 a survey of 17 large fields was made to study the amount of tipburn occurring under different cultural and soil conditions. The fields were visited at least three times and some four times each. Fields of different soil types and growers using different fertilizer combinations were selected. In most cases the lettuce was transplanted, but in one large field the seed was sown and no mineral nitrates were used. In this field tipburn injury was severe, being approximately twenty-five per cent. In another field where nitrate of

TABLE 1.—Effect of weather and different treatments on lettuce tipburn.

1926	April	May																	Number Plants
	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Maximum temperature	95	106	101	100	81	80	89	95	92	95	103	78	88	92	94	100	76	97	100	
Minimum temperature	43	46	49	52	54	38	35	41	57	57	53	57	55	49	53	55	46	45	48	
Humidity—Midnight	87	73	78	87	83	83	80	80	74	79	83	83	87	85	86	84	82	84	79	
Humidity—Noon	26	23	28	35	33	26	24	32	31	39	29	50	56	40	35	37	49	25	26	
Evaporation—grs.	35.8	46.0	40.2	31.5	36.3	41.2	40.3	31.0	41.5	25.8	51.2	18.0	13.3	28.2	38	30.5	25.4	54.9	51.7	
Average wind velocity	1.9	1.6	1.7	1.9	4.4	3.9	2.3	1.0	2.1	.9	3.0	2.2	2 5	1.3	2.3	1.5	4.6	4.0	1.9	
Soil temperature	75	78	74	79	74	68	70	76	78	80	81	72	76	80	80	80	69	80	84	
Head temperature	78	86	80	84	71	70	70	77	79	80	85	66	73	80	0	77	65	79	85	
Rainfall	0	0	0	0	.30	0	0	0	0	0	.02	0	0	0	.08	0	.11	0	0	
Tipburn:	Per Cent																			
Boarded	0	0	4.9	1.6	0	0	0	3.3	0	1.6	0	4.9	1.6	0	3.3	3.3	0	3.3	0	61
Irrigated	0	0	3 8	0	0	0	0	2.9	.9	0	1.9	8.6	7.6	4.8	5.7	12.4	3.8	1.9	1.9	105
Check	0	0	.4	0	0	0	0	.4	.8	.8	0	3.4	3.8	1.3	.4	8.9	2.9	.8	1.7	236
Nitrate of soda	0	0	1.2	0	0	0	0	2.2	.6	0	.3	3.7	5.9	.9	.3	10	3.7	.9	1.5	321
Check	0	0	.9	0	0	0	0	.9	0	.5	.5	2.8	1.4	1.8	3.7	11.9	5	.5	1.8	218
Shaded	0	0	0	0	0	0	0	1.6	0	0	0	3.3	0	0	0	0	0	0	0	60

REMARKS:

Plants in shaded plot headed poorly. Tipburn occurred on all that headed.

soda was used as a top dressing only one per cent of tipburn developed. For this particular season tipburn injury was worse on stiff soils than on loose soils. A careful analysis of the data does not reveal any apparent relationships between different fertilizer combinations, top dressings, the use of mineral or organic nitrogen and the amount of tipburn.

In 1926 an effort was made to determine, if possible, the cause of tipburn or the conditions under which it developed. Atmometers were placed on the lettuce beds to determine the relative daily evaporation. Maximum and minimum thermometers at the surface of the ground gave daily temperature readings in the open. A hygrothermograph was used to get a record of humidity. Weather observations were also made. Daily average wind velocity was secured by means of an anemometer.

SHADED PLOT

A section of a 2-row bed was shielded from winds by standing 12-inch boards on edge. A section of bed was shaded with burlap. One 2-row bed was kept thoroughly irrigated by turning water in the furrow between the rows. One bed was kept sprayed with bordeaux mixture and another with lime water. Other beds received treatments of basic slag, nitrate of soda and ammonium sulphate.

Observations and records were begun just before the plants began forming heads. Each head in the plots was examined daily and tipburned plants were marked with a small stake and recorded. Tables 1 and 2 show records of the years 1926 and 1927, during which seasons a high percentage of tipburn occurred.

TABLE 2.—Effect of weather and different

1927	April											
	15	16	17	18	19	20	21	22	23	24	25	26
Maximum Temperature F	80	92	101	99	94	96	95	83	74	85	75	89
Minimum Temperature	42	42	48	51	46	60	56	48	32	28	34	31
Humidity—Midnight	63	97	98	91	91	92	95	93	92	93	93	93
Humidity—Noon	69	65	54	45	46	53	50	96	38	37	48	36
Evaporation—grms	17.9	21.8	22.3	36.2	29.2	40.3	41.0	13.5	27.2	21.3	19.0	34.3
Average wind velocity, Mile	2.1	3.1	2.6	2.2	2.8	5.4	4.1	6.0	5.6	1.2	1.8	2.7
Highest soil temperature	59	64	71	72	72	76	78	65	62	64	61	68
Head temperature at 1 P. M.				78	79	81	82					73
Rainfall—Inches	0	0	.01	0	0	0	0	.23	.01	0	0	0
Per cent Tipburn:												
Boarded plot	0	0	0	0	0	0	0	0	0	5	1.8	0
Irrigated plot	0	0	0	0	0	1	4	10	0	2	3	2
Check plot	0	0	0	0	0	0	0	1.3	0	.7	.7	.7
Nitrate of soda plot	0	0	0	0	0	1.6	2.4	10.3	0	5.5	1.6	1.6
Basic slag plot	0	0	0	0	0	.8	0	10.8	0	4.7	2.3	0
Bordeaux Spray	0	0	0	0	0	0	0	10.4	0	4.3	1.2	0
Lime Spray	0	0	0	0	0	0	0	5.4	0	4.7	4.7	0
Check	0	0	0	0	0	0	.9	.9	0	2.7	1.8	0
Shaded plot												

Remarks:

(1) Most plants went to seed without heading.
(2) Heads large and early.
(3) Heads large but late.
(4) Heads early but small.
(5) Heads medium.
(6) Spray injury.
(7) Heads medium to large.
(8) Heads medium.
(9) 28 soft heads—24 tipburned.

treatments on lettuce tipburn

April				May									
27	28	29	30	1	2	3	4	5	6	7	8	9	Number Plants
94	93	94	100	83	88	95	99	103	96	95	96	--	
45	50	46	54	46	33	42	45	59	56	60	47	-----	
83	84	96	87	90	92	96	95	96	94	94	92	-----	
34	35	38	35	35	38	34	42	54	56	54	54	-----	
62 7	43.3	47.9	65.3	47.0	37.0	48.3	39.0	17.4	19.0	23.6	28.5	-----	
6 4	3.0	6.3	3.7	4.6	2.0	2.9	3.3	1.6	1.3	3.0	2.3	-----	
72	72	74	79	69	72	76	76	78	74	74	74	-----	
82	-------	85	85	67	76	81	83	84	76	-------	-------	-----	
0	0	0	0	0	0	0	.04	.45	.01	.01	0	-----	
0	0	0	0	0	0	0	0	1.8	3.5	1.8	0	0	58(1)
0	0	1	0	0	2	0	11	7	12	1	2	4	100(2)
2	0	4.7	0	0	2.7	0	.7	.7	4.7	4.7	5.3	4.7	150(3)
.8	0	0	0	0	2.4	2.4	3.9	9.5	6.4	4.6	3.2	1.6	126(4)
.8	.8	0	0	0	1.6	0	3.1	5.4	11.6	10.1	2.3	2.3	129(5)
1 2	0	0	0	0	3.1	0	4.9	2.5	3.1	13.5	4.3	6.8	163(6)
3.4	0	4.7	0	0	2.7	0	4.7	8 1	8 8	6.7	2	6.7	148(7)
0	0	0	0	0	4.5	5.4	1.8	10	8.2	10.9	3.6	3.6	110.8)
													58(9)

RESULTS AND DISCUSSION

The results seem to indicate an association between relative humidity and tipburn. Taking the 1927 observations, the greatest numbers of affected heads were noted on April 22d, 24th, May 4th, 5th, 6th and 8th. Of these days, April 22d and May 4th, 5th, 6th and 7th were showery and the evaporation was relatively low. It may be significant that on the days when much tipburn occurred on practically all of the plots, the evaporation of water from the atmometers was considerably less than on the day or days immediately preceding. Thermometers inserted in lettuce heads on the hottest days showed a maximum temperature of 85 degrees F. for the season. Soil temperatures were lower, the highest being 79 degrees F. The highest temperature in direct sunshine on one of the beds at the ground was 103 degrees F. on May 5th. This was a showery day, the evaporation was low and the tipburn injury was rather high.

In order to bring out the association of maximum daily temperature and daily evaporation with the amount of tipburn, correlations were worked out for the irrigated plot for 1926 and 1927 according to a working formula given by Hayes and Garber.*

Only two of these correlations are significant in the light of their probable errors. The negative correlation $r = -.551 \pm .111$ indicates a decided relation between low evaporation from the atmometers and the percentage of heads tipburned on the same day. There is also a relation between the daily maximum temperature and the percentage of tipburn the following day, though this factor is apparently somewhat less important than is evaporation.

TABLE 3.—Relation of daily maximum temperatures and daily evaporation to lettuce tipburn

	Year	Tipburn Same Day	Tipburn 1 Day Later	Tipburn 2 Days Later
Irrigated Plot:				
Daily Maximum Temperature	1926	$r = .028 \pm .155$	$r = .072 \pm .158$	
Daily Maximum Temperature	1927	$r = .201 \pm .153$	$r = .396 \pm .134$	$r = .221 \pm .151$
Daily Evaporation	1926	$r = -.498 \pm .116$	$r = +.091 \pm .158$	$r = .280 \pm .151$
Daily Evaporation	1927	$r = -.551 \pm .111$	$r = -.100 \pm .157$	$r = .058 \pm .158$
Nitrate of Soda Plot:				
Daily Evaporation	1926	$r = -.484 \pm .122$		
Daily Evaporation	1927	$r = -.719 \pm .075$		

The data in tables 1 and 2 show further that irrigated and nitrate of soda plots tipburned early, apparently because they headed early. The highest percentages of tipburn occurred on these plots also. The shade on the shaded plot was too dense for the proper development of the heads. However, out of 28 heads formed, 24 were affected with tipburn, indicating that direct light or heat from the sun's rays may not be a primary cause but rather that the humidity which was doubtless higher under the shade was of greater importance. Other treatments had no visible effects.

*Breeding Crop Plants, McGraw Hill, N. Y. 1927.

SUMMARY

During the year 1925 the greater tipburn injury occurred on the heavier soils. Tipburn was not visibly influenced by fertilizer combinations, top dressings, the use of organic or mineral nitrogen, or the method of planting, except as it is associated with growth. Irrigation tends to increase tipburn injury. Greater injury occurs in periods of low evaporation immediately following periods of high evaporation.

CONCLUSIONS

From the above results it would seem that field control of lettuce tipburn by cultural methods or fertilization is doubtful. Injury can be reduced by using methods which will retard the growth of the plants, but since this will produce lettuce of poorer quality, it is not desirable. Some varieties are less susceptible to tipburn than others, but again these varieties are not so desirable for market.

Since 1925 attention has been directed to the possibility of isolating adapted strains of the Big Boston variety which will have greater resistance to tipburn. This work is in progress and a number of promising strains have been isolated.

Potato Breeding, J. H. BEAUMONT, M. E. GARDNER and R. SCHMIDT, Leaders.

This project, begun in 1929 in coöperation with the U. S. D. A. Office of Horticultural Crops and Diseases, is a study of potato improvement. The object is to combine in one or more adapted varieties the characters of high yield, earliness, late blight and mosaic disease resistance and desirable commercial qualities. Breeding stock was secured through the kindness of Dr. F. A. Krantz, Minnesota Agricultural Experiment Station, Dr. Donald Reddick, New York (Cornell) Agricultural Experiment Station, and from Dr. William Stuart, Senior Horticulturist, Bureau of Plant Industry, Washington, D. C. During the year the inbred lines secured from these sources were continued, selfed seed of a number of disease resistant varieties and strains was secured, and a number of cross pollinations were successful. This seed will be grown next year and genetic and plant breeding studies of the different types of material will be made.

During the year approximately 10,000 seedlings were grown at the Mountain Station from crossed seed secured from Dr. Stuart. In addition approximately 300 tuber selections of breeding value were grown from which selfed or crossed seed were secured and further tuber selections made. In all more than 500 tuber selections of breeding or of commercial value were made from this material, which will be continued in small plots next year and undergo further selection.

Four of the more outstanding seedlings produced by Dr. Stuart were tested for yield and earliness at the Lower Coastal Plain Branch Station and seven of them at the Mountain Branch Station. These were grown in systematically replicated twenty-five hill plots. The results as an early crop at the Coastal Plain Branch Station are given in the following table. Those for the Mountain Branch Station are not yet available.

YIELD OF SELECTED SEEDLINGS AND OF STANDARD VARIETIES AT THE COASTAL PLAIN BRANCH STATION THE SPRING OF 1930

Variety	Total Yield Pounds—Per 25 Hills	Yield U. S. No. 1 Pounds—Per 25 Hills	Yield U. S. No. 1 Pounds Per Acre	Per Cent Culls
S 41914	28.06 ± 1.01*	24.88 ± 1.04	13,895	11.3
S 41956	26.94 ± 0.97	16.25 ± 0.68	9,075	39.7
S 42667	27.94 ± 1.01	27.19 ± 1.14	15,185	2.7
S 42672	28.25 ± 1.02	27.00 ± 1.13	15,079	4.4
Irish Cobbler	19.54 ± 0.53	18.32 ± 0.59	10,231	6.2
Green Mountain	23.75 ± 0.86	22.94 ± 0.96	12,812	3.4

The results of the first year's test indicate significant differences in total yielding ability between Irish Cobbler, Green Mountain and the 4 seedlings. The two seedlings 42667 and 42672 yielded more U. S. No. 1 tubers than Irish Cobbler and Green Mountain, although the differences for Green Mountain are not as significant as those for Irish Cobbler. The two seedlings 41914 and 41956, and especially the latter, tended to nobbiness and a large percentage of these were classed as culls.

Seedling 42667 matured only slightly earlier than, and seedling No. 41956 with Green Mountain, while seedlings 41914 and 42672 matured approximately midway between Green Mountain and Irish Cobbler. Seedling No. 42667 seems to be quite outstanding in tuber characters, as well as yielding ability. The tubers were uniformly large, chunky, white, very shallow eyed and smooth.

Vegetable Fertilizer Project, ROBERT SCHMIDT, J. H. BEAUMONT, Leaders.

This project is intended both as a study of the fertilizer requirements of various vegetable crops and as a study of size of plot best suited for this work.

In the fall of 1929 a crop of spinach was planted on one-half of the two acre field allotted to this study and a crop of cabbage on the other. Both were failures because of insufficient fertilization or excessive rainfall, or both. In the spring of 1930 a crop of Irish potatoes followed the cabbage and a crop of early sweet potatoes followed the spinach. The yields were low, though the sweet potatoes, requiring much less fertilization to produce a crop, gave a satisfactory yield. It was the original plan to secure these yields of crops in rotation for the first two or more years, using only a light side dressing of nitrate of soda as a maintenance fertilizer, in order to have a record of the behavior of the individual plots before differential fertilizers were applied and to avoid surplusses of mineral nutrients in the soil. In order to continue these studies which have been delayed by adverse weather conditions, a uniform application of a fertilizer analyzing 4 per cent phosphoric acid, 2 per cent nitrogen, and 2 per cent potash will be made to all succeeding crops until the fertilizer plot work is begun. It is not anticipated that the residual effects of such a minimum fertilization will materially interfere with future results.

* Probable error secured by "Deviation from the mean method." See Hayes and Garber, *Breeding Crop Plants*, pp. 79—84, 1927.

Fig. 1.—PARENTS. Table Queen-White Bush

Fig. 2.—First Generation.

Fig. 3.—Second Generation.

Vegetable Trial and Observation Garden, R. Schmidt, Leader.

Variety tests were carried on at Raleigh with squash, cucumbers, cantaloupes, tomatoes, sweet corn, lima beans and peppers.

Of seven varieties of bush squash, Golden Summer Crookneck and Giant Crookneck gave the best yields. Summer Crookneck is also becoming increasingly popular on the markets.

Seven varieties of slicing cucumbers and seven varieties of pickling cucumbers were compared for yield and earliness. Of the slicing type, Kirby and Green Pack were earliest, while Imperator and Green Pack were the heaviest yielders in number of fruits. Imperator is a long cucumber, averaging 10 to 12 inches, while Green Pack is short, averaging 5 to 7 inches. Of the pickling cucumbers Early Green Cluster was the heaviest yielder, closely followed by Extra Early Green Prolific.

Twelve of the leading varieties of cantaloupes were planted for comparison. Golden Champlain was earliest, but seemed to be very susceptible to wilt and the vines soon died. Early Knight was also a total loss because of heavy infections of leaf spot and some wilt. The heaviest yields were given by Hale's Best and Sugar Rock, which were also fairly early maturing varieties.

In the sweet corn variety tests, the Kessler, a new variety from Indiana, showed much promise.

Tomatoes and peppers were so badly affected with bacterial wilt that comparisons could not be made.

Of the lima bean varieties, only two small seeded varieties, Henderson's Bush and Philadelphia, set a crop. All the large seeded varieties failed to set more than a few pods, although the plants made a good growth. The failure to set a good crop of pods is a common occurrence for the large seeded varieties in this locality.

In the season of 1928 a few hills of Table Queen and White Bush squash were planted in adjacent rows. No other varieties of squash were in the vicinity. In 1929 a few volunteer squash plants came up on this same plot of ground. One hill of two plants was allowed to remain. These plants retained the running habit of the Table Queen, while the fruits were white like the White Bush with a shape which was a combination of the two varieties as illustrated in Figures 1 and 2. Seed was saved from one representative fruit and several hills planted in the spring of 1930. The resulting second generation progeny are shown in Figure 3.

This is an illustration of what may happen in the home saving of seeds of squashes, pumpkins, cucumbers and melons, unless care is taken to segregate varieties so that cross pollination cannot take place.

J. H. Beaumont,
Head, Department of Horticulture.

RESEARCH IN POULTRY

COST OF EGG PRODUCTION WITH TWO FLOCKS RECEIVING A SINGLE SOURCE OF ANIMAL FEED AND A DOUBLE SOURCE

This project is a continuation of a series of experiments on the value of animal feeds from various sources. These experiments have been conducted at the Coastal Plain Branch Station at Willard, N. C., in coöperation with the North Carolina State Department of Agriculture. The flocks under study started with 150 adults and pullets and were, as far as could be practically determined, of equal health and productive capacity.

The mash fed in flock 1 consisted of bone meal 4 lbs., sodium chloride 1 lb., meat meal 20 lbs., pulverized oats 20 lbs., wheat middlings 20 lbs., corn meal 25 lbs., and wheat bran 10 lbs.

The mash was left in the hoppers before the birds at all times.

TABLE 1

FLOCK 1

Month	No. Birds	No. Eggs	Per Cent Produced	Mash Consumed	Cost of Mash	Grain Cons.	Cost of Grain	Pounds Feed to Produce Dozen Eggs	Feed Cost Per Dozen Eggs	Deaths	Amount Animal Protein Consumed
1929											
November	150	638	14.1	468	14.93	567	14.17	19.5	.548	0	51.4
December	150	897	19.3	431	13.75	738	18.45	15.6	.430	2	47.4
1930											
January	148	1,527	33.2	656	18.89	569	13.31	9.6	.253	0	72.0
February	148	2,100	50.6	624	17.97	581	13.60	6.8	.180	0	68.6
March	148	2,634	57.4	586	15.82	681	16.21	5.7	.147	3	64.0
April	145	2,361	54.3	489	13.69	470	10.86	4.8	.125	6	53.7
May	138	1,983	46.3	430	12.04	683	15.78	6.7	.168	2	47.3
June	136	1,578	38.6	360	10.19	566	13.07	7.0	.177	0	39.6
July	134	1,045	25.6	369	9.63	472	9.86	9.6	.223	5	40.5
August	129	767	19.8	389	10.50	352	8.80	11.5	.300	5	42.7
Totals		15,530		4,802	137.41	5,679	134.11	8.1	.210		

Flock 2 received the following mash mixture: corn meal 25 lbs., wheat middlings 16 lbs., pulverized oats 16 lbs., wheat bran 10 lbs., meat meal 55 per cent protein 10 lbs., dried milk 30 per cent protein 18 lbs., bone meal 4 lbs., table salt 1 lb.

Grain mixture for both flocks consisted of corn 50 lbs., heavy oats 30 lbs., and wheat 20 lbs.

One pint of grain mixture was fed to each twelve birds in the litter in the morning and the same in the evening.

The results of this experiment are shown in Tables I and II, the study being presented on a ten months basis due to the fact that the beginning of the twelve months poultry year at this Station is being shifted from November 1st to October 1st and this report is issued before September records can be figured.

TABLE 2

FLOCK II

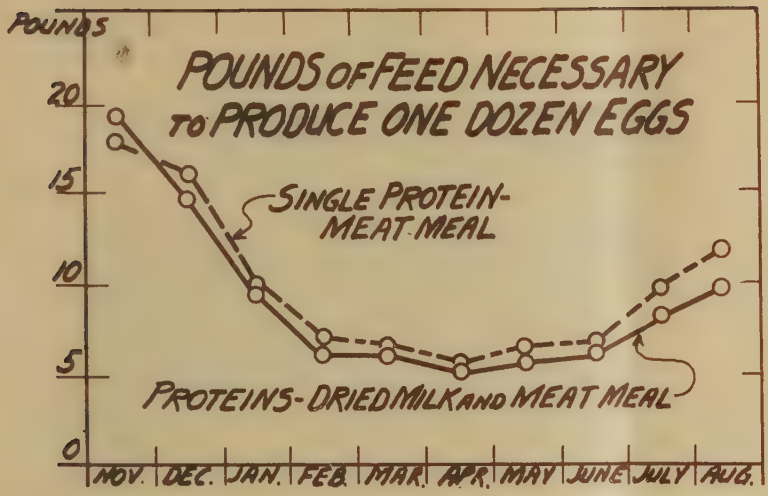
Month	No. Birds	No. Eggs	Per Cent Produced	Mash Consumed	Cost of Mash	Grain Consumed	Cost of Grain	Pounds Feed to Produce Dozen Eggs	Feed Cost Per Dozen Eggs	Deaths	Amount Animal Protein Consumed
1929 November	150	678	15.1	532	23.40	567	14.17	19.4	.665	0	58.5
December	148	1,086	23.7	518	22.79	799	19.98	14.5	.472	2	56.9
1930 January	147	1,671	36.6	606	25.45	559	13.08	8.3	.277	1	67.0
February	146	2,117	51.8	540	22.68	578	13.53	6.3	.205	1	59 4
March	147	2,565	56.2	510	19.18	690	16.42	5.6	.166	2	56.0
April	144	2,330	53.9	449	16.70	628	14.51	5.5	.161	1	49.3
May	143	1,929	43.5	478	17.78	599	13.84	6.7	.197	7	52.8
June	132	1,517	38.3	285	10.60	569	13.14	6.7	.188	3	31.3
July	126	1,133	29.6	289	11.04	476	9.95	8.1	.222	6	31.7
August	120	935	25.6	354	13.88	420	10.50	9.9	.312	5	39.0
Totals		15,961		4,561	183.50	5,885	139.12	7.9	.242		

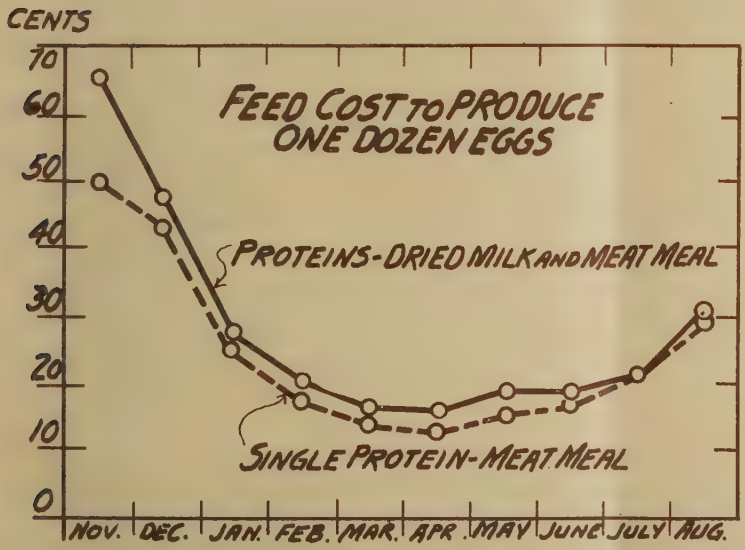
Analysis of the tables shows the following: (1) a tendency for higher egg production in the flock being fed animal protein from two sources; (2) it took 0.2 pounds more feed to produce one dozen eggs in the flock fed the single source of animal protein, but the feed cost to produce one dozen eggs was $0.032 greater, in these studies, in the pen fed two sources of animal protein than for the pen fed the single source.

Mortality was higher in Flock 2 than in Flock 1, but in no way could be ascribed to the feeding.

EXPERIMENTS IN CRATE FATTENING

These experiments were conducted to determine the relative efficiency of two types of fattening rations fed to finish off broilers. A total of thirty-four lots of birds, consisting of 838 birds, were fattened in this experiment.





These birds are designated as Lots 1 and 2. The ration fed Lot 1 consisted of the following: Corn meal 40 lbs., pulverized oats 40 lbs. meat meal 20 lbs. Lot 2 was fed corn meal 38 lbs., pulverized oats 38 lbs., meat meal 10 lbs., dried milk 14 lbs. Both lots of birds were fed all they would clean up in about thirty minutes three times a day. The feed was mixed to a batter with water.

The results of this experiment are shown in Tables 1 and 2.

TABLE 1
LOT 1

Pen No.	No. Birds	Date in 1930	Date out 1930	Days Fed	Wt. in	Wt. out	Gross Gain Lbs.	Individual Gains, Lbs.	Gross Gain, Per Cent	Lbs. Feed Consumed	Cost of Feed	Feed Cost Per Lb. Gain
3	24	2/10	2/19	9	28	38	10	0.41	36.0	39	1.09	.109
5	24	2/18	2/27	9	32	44	12	0.50	37.5	51	1.43	.119
7	24	2/24	3/5	9	37	49	12	0.50	32.4	48	1.34	.111
9	24	3/3	3/12	9	39	50	11	0.45	28.2	57	1.60	.145
11	24	3/10	3/20	10	39	51	12	0.50	30.7	50	1.40	.116
13	24	3/17	3/28	11	39	51	12	0.50	30.7	56	1.57	.130
15	24	3/24	4/4	11	37	51	14	0.48	37.8	46	1.29	.092
17	24	4/4	4/10	8	38	52	14	0.48	37.0	44	1.23	.087
19	24	4/7	4/17	11	45	56	11	0.45	24.4	62	1.74	.158
21	32	4/15	4/24	9	58	75	17	0.53	29.3	64	1.79	.105
23	24	4/22	5/1	9	47	59	12	0.50	25.5	60	1.68	.140
25	24	4/29	5/1	10	41	74	15	0.62	36.5	58	1.62	.108
27	22	5/5	5/16	11	46	53	7	0.32	15.2	59	1.65	.235
29	24	5/13	5/23	10	41	56	15	0.62	36.5	52	1.46	.097
31	24	5/27	6/5	9	45	62	17	0.71	37.7	55	1.54	.090
33	24	6/2	6/11	9	43	59	16	0.66	37.2	61	1.71	.106
35	22	6/16	6/26	10	43	54	11	0.50	25.2	40	1.12	.101
Totals 17	412	------	------	------	698	934	218	0.53	31.2	902	25.26	.116

DISCUSSION

Weights in and out between the two lots show only a very slight difference, that of thirteen pounds. The individual gain was 0.530 pounds in Lot 1 as compared with 0.555 pounds in Lot 2. Lot 1 consumed three pounds of feed less than Lot 2, the gross cost of feeding being 7.36 less in Lot 1 than in Lot 2. The feed cost per pound gain in Lot 1 was $0.116, while in Lot 2 it was $0.141. These figures indicate that in these experiments where meat meal is used in fattening as a single source of animal protein, it produces nearly as heavy gains and at a cost of $0.025 per pound less. This does not detract from the fact that the added milk in Lot 2 produced a better type of edible meat than those in Lot 1, which should pay a premium on a discriminating market.

TABLE 2

LOT II

Pen No.	No. Birds	Date In	Date Out	Days Fed	Wt. In	Wt. Out	Gross Gain, Lbs.	Individual Gain, Per Cent	Gross Gain, Per Cent	Lbs. Feed Consumed	Cost of Feed	Feed Cost Per Lb., Gain
4	24	2/10	2/19	9	25	34	9.0	0.375	36.0	39	1.40	0.155
6	24	2/18	2/27	9	34	48	14.0	0.583	41.2	53	1.91	0.136
8	24	2/24	3/5	9	37	48	11.0	0.460	29.7	51	1.84	0.167
10	24	3/3	3/13	10	37	50	13.0	0.540	35.1	56	2.02	0.155
12	24	3/10	3/20	10	39	53	14.0	0.580	35.9	50	1.80	0.128
14	24	3/17	3/28	11	39	57	18.0	0.750	46.0	57	2.05	0.113
16	24	3/24	4/8	11	37	48	11.0	0.460	30.0	45	1.62	0.147
18	24	4/2	4/10	8	37	52	15.0	0.625	40.5	45	1.62	0.108
20	24	4/7	4/17	11	45	56	11.0	0.460	24.4	61	2.20	0.200
22	32	4/15	4/24	9	52	69	17.0	0.530	32.6	63	2.27	0.133
24	24	4/22	5/1	9	51	63	12.0	0.500	23.5	61	2.20	0.183
26	24	4/29	5/9	10	41	56	15.0	0.625	36.5	58	2.09	0.139
28	24	5/5	5/16	11	46	58	12.0	0.500	26.0	56	2.02	0.168
30	24	5/13	5/23	10	48	62	14.0	0.580	29.1	53	1.91	0.136
32	24	5/27	6/5	9	42	58	16.0	0.670	38.0	55	1.98	0.123
34	24	6/2	6/11	9	44	58	14.0	0.580	31.8	61	2.20	0.157
36	24	6/16	6/26	10	42	57	15.0	0.620	35.7	41	1.48	0.098
Totals 17	416	------	------	------	696	927	231	0.555	33.2	905	32.61	0.141

STUDY OF THE INTERMITTENT REACTOR TO THE AGGLUTINATION TEST FOR PULLORUM DISEASE

(Bacillary White Diarrhea)

This project was conducted under Adams funds and has been under investigation for the past three years. Prior to the present fiscal year the objects of the investigation centered around the frequency and cause of the intermittency in reaction to the agglutination test by carriers of pullorum disease. Later the investigation shaped itself into a suggested method of testing at short intervals, being based on experimental findings brought out in the investigation. This system was adopted by the North Carolina State Depart-

ment of Agriculture during the testing season of 1920-30 with very effective results.

Major findings in this investigation and in the application of the short interval method of testing are as follows:

PREVALENCE OF THE INTERMITTENT REACTOR

In the experimental foundation flock of reactors under study (Flock 1) 12 or 44 per cent of 27 birds reacted intermittently to the test. (On this flock bi-monthly tests have been run for thirty-six months, the same type of organisms being used as antigen during that period of time.) Breeding reactor on reactor, in flock 2, we find 19, or 73.1 per cent of 26 birds, now under test for nearly 24 months in flock 2 as intermittent reactors. Again breeding reactor on reactor, we find 18, or 69.2 per cent of 26 birds in Flock 3 as intermittent reactors. In the short interval testing conducted in North Carolina this year on 37,893 birds, 1,859 birds, or 34.8 per cent of 5,053 reactors, were negative on the first test and would have been passed as negative birds if only a single annual test had been applied. This latter per cent is in relatively close agreement with the experimental findings cited, considering the fact that routine work on large numbers does not admit of as exacting technic as is necessarily applied in experimental work.

Analysis of the results of field work as cited above show no great difference in the per cent of intermittent reactors as far as age or sex are concerned, which is in close agreement with our experimental findings. Breeding reactors experimentally apparently shows no constant genetical factor active in the reproduction of intermittent reactors as we have obtained both constant and intermittent female; and intermittent male with a constant female; a constant male with a constant female; and an intermittent male with an intermittent female. Likewise, there apparently exists no relationship between the positive and the negative phase of the test and the delivery of infected eggs as individual studies show that approximately the same relative ratio of delivery of infected eggs is maintained during the positive and the negative phase of the test.

As to comparative per cent of infected eggs delivered by the constant reactor and the intermittent reactor, the following results indicate that apparently there is no definite relationship between the above and the serum titer of the reactor.

DELIVERY OF INFECTED EGGS

INTERMITTENT REACTORS

1st year	4,030 eggs	658 positive	16.3% positive
2nd year	1,530 eggs	282 positive	18.4% positive
Total	5,560 eggs	940 positive	16.9% positive

CONSTANT REACTORS

1st year	2,772 eggs	416 positive	15.0% positive
2nd year	1,352 eggs	248 positive	18.3% positive
Total	4,142 eggs	664 positive	16.1% positive

The results of these tests, while admitting the fact that under the best of conditions, such analyses do not return 100 per cent results, give rise to the belief that as the reactor matures the per cent of infected eggs delivered increases.

Results of a study of the negative phases on intermittent reactors show that the duration of this phase in 117 instances in which birds were tested at fifteen-day intervals was: 1 period, 50, or 42.7 per cent; 2 periods, 17, or 14.5 per cent; 3 periods, 21, or 18 per cent; 4 periods, 7, or 6 per cent; 5 periods, 8, or 5.1 per cent; 6 periods, 6, or 5.1 per cent; 8 periods, 6, or 5.1 per cent; 9 periods, 1, or 0.9 per cent; 11 periods, 1, or 0.9 per cent. With a flock tested for 12 months at 30-day intervals showing 58 negative phases, 31, or 53.4 per cent, were of one period duration; 8, or 13.8 per cent, were for two periods; 9, of 15.5 per cent, for three periods; 3, or 5.2 per cent, for four periods; 6, or 10.3 per cent, for five periods;; 1, or 1.7 per cent, for six periods. These figures further emphasize the lack of safety brought about by accrediting on the single annual test. Season apparently exerts no influence on these negative phases, and while there may exist a tendency for stabilization of positive tests as the birds mature, in a few instances the numbers of such are so small as to be practically negligible.

In the work cited above only one intermittent reactor was studied, in which, if tested every 30 days, would not have been positive in a 1:25 dilution in six tests, and it is on the basis of the above findings that the short interval method of testing was adopted in North Carolina.

DEVELOPMENT OF ANTIBODIES IN PROGENY OF REACTORS

It is of interest and practical importance to note the development of antibodies in the progeny of reacting birds. In such studies conducted at this Station 116 birds were bred from reacting birds and were autopsied at or before six months of age on account of lack of personnel to carry studies further. Of these only 26, or 22.4 per cent, were negative to the agglutination test at six months, and of the 26 negative birds 4 showed lesions of pullorum infection and yielded cultures of S. pullora. If these 90 birds which proved to be positive to the agglutination test in six months were tested monthly from the age of two months on in a dilution of 1:25, 33, or 36.7 per cent, would have been removed in two months; 72, or 80 per cent, in three months; 82, or 91.1 per cent, in four months; 88, or 97.9 per cent, in five months, and 90, or 100 per cent, in six months. This study further emphasizes the value of testing at short intervals.

RESULTS OF ONE SEASON'S TESTING AT SHORT INTERVALS IN NORTH CAROLINA

Testing under this system was commenced in September, 1929, with 327 flocks, involving over 40,000 birds. Of this number, 47 flocks dropped out of the testing or were discontinued for violation of rules. The results are as follows: 41 flocks, containing 4,399 birds, were accredited on two successive negative tests; 68 flocks, containing 6,178 birds, were out on three tests; 89 flocks, containing 7,056 birds, went out on four tests; 29 flocks, containing 4,300 birds, were out on five tests; 1 flock, with 58 birds, went out on six tests; leaving 49 flocks on the 15th of April, containing 1,479 birds,

still not accredited. Of these, 23 flocks had one negative test when the work was discontinued. In short, the status of flocks under test at the present time, when shortage of funds has necessitated discontinuance of testing, is as follows: 231, or 82.5 per cent, of 280 flocks have been accredited; 33, or 11.8 per cent, have one negative test; and 16, or 5.7 per cent, are still positive, having had five or six tests.

MORTALITY FIGURES ON CHICKS HATCHED FROM BLOOD-TESTED FLOCKS

Lack of personnel made it impossible to properly follow up this work at the hatcheries, but from card returns from North Carolina poultrymen the following reports are given on chicks from these birds:

SHORT INTERVAL TESTING PLAN USED (1929-30)

Number blood-tested chicks purchased this year 24,383
Number died from disease 1,174
Per cent loss, 4.8 per cent.
Number non-blood-tested chicks purchased this year (1929-30) 6,075
Number died from disease 2,526
Per cent loss, 41.5 per cent.
Non-tested chicks purchased last year (1928-29) 25,911
Loss 11,239
Per cent loss, 31.3 per cent.

ANNUAL TESTING PLAN USED

Number tested chicks purchased last year (1928-29) 15,860
Loss 2,978
Per cent loss, 18.8 per cent.

SUMMARY

In conclusion, we consider this work still in the embryonic stage. We will still have unexplainable outbreaks of pullorum disease when least expected and when every indication points against such, even when we have accredited hatcheries. It is hoped, however, that if we can maintain our gain of this year and vigorously push ahead for five more years that North Carolina will be fairly well supplied with relatively safe breeding centers as far as pullorum disease is concerned.

NOTATION: The Experiment Station wishes to make acknowledgment of the splendid and efficient coöperation afforded by Dr. William Moore, State Veterinarian, and his personnel, in lending every aid in contributing toward the accumulation of experimental information. The field work is carried out in its entirety by the State Department of Agriculture, the efficiency of this work being reflected in results obtained.

INVESTIGATIONS OF SEPTICEMIC DISEASES AMONG FOWLS

Studies of Fowl Typhoid

This project is carried out under Adams funds and for the past year specific investigational work has been conducted on soil pollution and the immunity produced by vaccination against fowl typhoid. Results obtained are listed—

duration of immunity produced by vaccination against avian typhoid by using the single, double, and triple vaccinations, as measured by the macroscopic agglutination test.

Single Vaccination: Eighteen vigorous S. C. Rhode Island Reds, including two males, were vaccinated against avian typhoid on October 21, 1929. These birds were April hatched and received 1 c.c. of a standardized saline vaccine. No antibodies against *E. sanguinaria* were observed in a preliminary agglutination test. Agglutination tests were made of the bird's serum against a specific antigen of *E. sanguinaria*, the same strain being used for the antigen as the vaccine. The serums were also run against an antigen of *S. pullora* as a check of cross-agglutination properties. Results of these tests showed antibodies present in a dilution of 1:25 or greater for the duration of time as shown in Table I, Column 1.

Double Vaccination: Eighteen birds similar to those treated with the single vaccination and including three males were given two vaccinations of 1.0 and 1.5 c.c. respectively, the same vaccine as noted above being used. These birds were negative to the agglutination test prior to vaccination. The duration of a positive serum in a dilution of 1:25 or greater is shown in column 2, Table I.

Triple Vaccination: Sixteen birds, similar to those in the single and double vaccination tests and including one male, were vaccinated three times at seven-day intervals with dosages of 1 c.c., 1.5 c.c., and 2 c.c. of vaccine, re-

TABLE I

SHOWING THE NUMBER OF WEEKS AFTER VACCINATION AGAINST AVIAN TYPHOID THAT POSITIVE AGGLUTINATION TESTS ARE OBTAINED

Week After Vaccination	One Vaccination		Two Vaccinations		Three Vaccinations	
First, Second and Third Tests	1 cc—18 Birds		1 cc and 1.5 cc, 7 Days Apart—18 Birds		1 cc, 1:5, 2 cc 7 days Apart—16 Birds	
	No. Birds	Per Cent	No. Birds	Per Cent	No. Birds	Per Cent
1					1	6.2
2	1	5.5	1*	5.5	7*	43.7
3	6**	33.5	6*	33.5	2*	12.5
4	8	44.0	5*	27.8	3	18.8
5	2	11.1	2	11.1	3	18.8
6	1	5.5	1	5.5		
7			3	16.7		

* Birds withdrawn from test for artificial infection work while positive at time of artificial infection work.

spectively being used, the same vaccine being employed as above. The duration of a positive serum in a dilution of 1:25 or greater is shown in column 3, Table I.

DISCUSSION OF TABLE I

From a practical standpoint, it is apparent that there is no outstanding benefit, as far as the immunity demonstrable by agglutination tests is concerned, in vaccinating the birds twice or three times. Considering the fact that all birds received the first vaccination on the same date, the antibody content in the serum of the greater per cent of birds vaccinated in Groups I, II, and III ran out in the 1:25 dilution on four weeks after the first vaccination. In Group I one bird gave a positive test up to six weeks after the initial vaccination. In Group II three birds were positive eight weeks after the initial vaccination and in Group III three birds were positive eight weeks after the initial vaccination.

As noted in Table I. six birds were withdrawn from each of the three groups of vaccinated birds and artificially infected with *E. sanguinaria* (Allen) in thirty, sixty, and ninety-day intervals after vaccination. The results of these artificial infection studies are listed as follows:

SUMMARY OF ARTIFICIAL INFECTION STUDIES OF BIRDS HAVING SINGLE VACCINATION

Of two birds infected thirty days after vaccination, both developed clinical typhoid, but threw off the disease.

Of two birds infected sixty days after vaccination, one bird resisted the infection for three weeks after succumbing, but died of the disease. The second bird showed only a slight elevation of temperature on one day, but no clinical symptoms of typhoid.

Of birds infected ninety days after vaccination, one bird resisted the infection for sixteen days before succumbing to the disease, while the second showed no symptoms of typhoid in any form.

SUMMARY OF ARTIFICIAL INFECTION STUDIES OF BIRDS HAVING TWO VACCINATIONS

Of two birds inoculated thirty days after vaccination, both birds died of avian typhoid, although one bird resisted the disease for twenty weeks.

Of two birds inoculated sixty days after the second vaccination, neither showed clinical typhoid.

Of two birds inoculated ninety days after the second vaccination, the first died of typhoid after resisting the disease for ten days, while the second contracted and resisted the disease for nine days, at which time its condition necessitated its disposal.

SUMMARY OF ARTIFICIAL INFECTION STUDIES OF BIRDS VACCINATED THREE TIMES

Two birds inoculated thirty days after third vaccination showed slight elevation of temperature and maintained a high positive serum titer against typhoid until the present time (forty weeks after inoculation).

Of two birds inoculated sixty days after the third vaccination one showed a slight elevation of temperature for half a day, while the second showed no clinical symptoms of typhoid. Neither of these birds succumbed to the disease.

Of two birds inoculated ninety days after the third vaccination, one showed definite clinical typhoid and the second no indications of it. Neither bird died of the disease.

RANGE INFECTION STUDIES

At pen 5 in the disease plant a yard was set aside for soil pollution studies. This ground was virgin soil, having never before been ranged by chickens. On October 21st nine birds having received a single vaccination against avian typhoid were placed on this range. On October 28th nine birds having received two vaccinations were placed on this range, and on November 4th eight birds having received three vaccinations were added to this flock. Of these birds 22 were vigorous Rhode Island Red pullets and four Rhode Island Red cockrels.

INFECTING THE SOIL

On November 12th the pen was seeded with five quarts of the specific strain of *E. sanguinaria* used in these studies (Allen). This was a 24-hour bouillon emulsion and proved virulent on two negative check birds. On November 14th five White Leghorn pullets and one Buff Orpington were added to the pen as check birds, these birds not having received any prophylactic vaccination.

On November 28th Artificial Infection Bird 1, which had shown clinical typhoid, was added to the pen, it probably being in the carrier stage. On December 24 Artificial Infection Bird 2, which had shown severe typhoid on infection, was added to the pen, it being without doubt in the carrier stage. On December 2d there was an abundance of sulphur colored droppings on the dropping boards. On December 5th Bird 8 was placed in Pen 5, though this bird did not show clinical typhoid on inoculation. On this same day the Buff check bird died, the organism of typhoid being recovered. On December 12th Birds 13 and 14, both showing suspicious elevations of temperature on artificial infection, were placed in Pen 5. On December 29th and 30th Birds 4 and 5 were taken to Pen 5, Bird 4 showed severe clinical typhoid, having a temperature of 109.7 degrees when placed in the pen, and dying in pen on January 10th of typhoid. Bird 5 showed no evidence of typhoid during artificial infection studies or later. On January 3d Birds 9 and 10 were added to the pen, neither of these birds showed clinical typhoid during artificial infection studies or later. On January 9 and 10, Birds 15 and 16 were added to Pen 5, these bird not reacting strongly to artificial infection, but 15 succumbed to peritonitis on January 23d. On January 26th Birds 5 and 6 were added to the pen, these birds not reacting to inoculation of *E. sanguinaria*. On February 5th Bird 5 died of typhoid, while Bird 6 maintained its health. On February 16th Bird 17 was taken to the plant in the carrier stage, it showing a temperature of 109 degrees. This bird died in the pen on March 12th of typhoid. Bird 18 was taken to the pen on February 10th, this bird not showing or contracting clinical typhoid.

SUMMARY

The pen was populated and seeded as noted at the beginning of this study. Six negative check birds were added, 18 birds were taken from the pen and artificially infected. Of these 15 were returned, probably in the carrier stage. Of these returned, two died of typhoid and one check bird succumbed. Of the remaining five check birds, two died of causes other than typhoid and of the eight birds vaccinated and not artificially infected, not one showed any evidences of typhoid. The range studies were discontinued on the 1st of June and from July 15th until August 1st forty Rhode Island Red cockrels from eight to ten weeks old were ranged on this run with no takes from typhoid.

R. S. DEARSTYNE,
Head, Poultry Department.

RESEARCH IN RURAL SOCIOLOGY

Within the last year the Department of Rural Sociology has continued to work on the two projects which were under way at the time of our last annual report, namely: (a) "A Study of One Hundred and Fifty-four Rural Communities in Seven Typical North Carolina Counties," and (b) "A Study of the Influence of Community Factors Upon Family Living Among White Farm Owner and Tenant Operators in Wake County, North Carolina."

During the year the third bulletin, by Dr. Anderson, developed out of the two standard of living projects conducted in 1926-27 and 1927-28, appeared in March, 1930, as Technical Bulletin No. 37, entitled, "Factors Influencing Living Conditions of White Owner and Tenant Farmers in Wake County."

There also appeared in June, 1930, the first bulletin on the present standard of living project. This bulletin was by Dr. Anderson and Mr. Loomis and was entitled, "Migration of Sons and Daughters of White Farmers in Wake County, 1929," No. 275.

The manuscript on the Rural Community Organization Bulletin will be presented by January 1, 1931.

The next bulletin, the manuscript for which is about two-thirds completed, will be "A Study of the Rural Churches of Wake County, North Carolina and the Analysis of Their Influences Upon Influence of Farm Family Standards of Living."

The rural church bulletin will be followed by similar bulletins on the rural school, rural stores, rural health agencies, rural recreational agencies and general community agencies.

The final analysis of the present project of the standard of living will consist of an attempt, by means of institution and agency indexes, to measure the total influence of community life upon farm family standard of living.

The Department will attempt to complete the next three of these standard of living bulletin manuscripts by July 1, 1931.

It is the purpose of the Department, with the assistance of R. W. Green, who originally worked on the project, to bring to completion a manuscript on "Membership relations and problems in North Carolina Farmers' Coöperatives."

The Department has no recommendations to make at this time concerning future projects due to the fact that the data now at hand will take more than the remainder of this year for completion.

RURAL COMMUNITY ORGANIZATIONS IN SEVERAL TYPICAL NORTH CAROLINA COUNTIES

A study of 154 and an attempt to the factors making for their success or failure.

I

Manuscript completed in from 30 to 60 days.

Data presented under following headings.

Section	I.	Description of areas studied and methods used.
Section	II.	Purposes and objectives of organizations studied.
Section	III.	Membership in organizations.
Section	IV.	Meetings of organizations.
Section	V.	Programs of organizations.
Section	VI.	Projects of organizations.
Section	VII.	Overhead affiliations.
Section	VIII.	Finance of organization.
Section	IX.	Difficulties and problems encountered.
Section	X.	Data from supplementary schedules on leadership in and problems of organization.
Section	XI.	The relation of the organizations to types of farming, roads and historical factors.
Section	XII.	Summary and conclusion.

II

A number of case studies of typical organizations selected from the 154 analyzed in Part I.

CARL C. TAYLOR,
Head, Department of Rural Sociology.

RESEARCH IN ZOOLOGY AND ENTOMOLOGY

The research in the Department of Zoölogy and Entomology is centered around the study of insects and other animals of economic importance and around the taxonomy of certain insect groups. In general, the work on taxonomy is carried on by members of the teaching staff who have no regular time for research but use odd hours during the week for this work. Taxonomic work lends itself to such irregular hours because it can be laid aside at any time. Economic studies cannot be pursued at odd hours in this way for economic work requires careful and detailed attention at specified times.

The economic studies have been concerned with the corn ear worm, the harlequin bug and the corn root worm, the wintering of bees and a survey of the honey plants of the State. In the corn ear worm project, we have studied principally the factors which influence the mortality of the insect during the pupation period in the soil.

In the studies of the harlequin bug the chief emphasis has been placed on the use of trap crops and methods of handling these crops for the control of this important pest of cabbage and collards.

The rotation experiments on the corn root worm have been continued at the Coastal Plains Test Farm. The extreme dry weather during the spring effected the breeding of this insect to such an extent that no conclusions can be drawn from this year's work.

In studying the factors which influence the wintering of bees it has been determined that it is desirable to give protection to bees in our climate and that the most successful colonies are those that contain young one-year-old queens.

The survey of the honey producing plants will eventually show the regions of the State best adapted to commercial honey production and will also influence beekeeping practices.

The taxonomic work has been concerned chiefly with the leaf cutter bees, the Homoptera and the crickets. A thorough revision of the leaf cutter bees of North and South America is in progress.

The studies of the Homoptera have been concerned chiefly with the preparation of the various volumes of the catalogue of the insects of the world, and the studies of collections from different regions of the world.

The studies of the crickets has dealt principally with the habits, ecological relations and systematics of the crickets of North America.

Brief reports by the project leaders are appended.

One project, project No. 22, Studies in Human Inheritance, has been discontinued due to the resignation of Dr. L. H. Snyder; and one new project, Project No. 26, The Genetics of Habrobracon, has been added.

PROJECT REPORTS

Project No. 1. Biology of the Homoptera, Z. P. Metcalf, Leader.

This project has been concerned chiefly with the morphology and systematics of this group. A thorough study of the head has been made and is nearly ready for publication. A study of the embryology of the periodical cicada is in progress. Special studies on large collections of these insects from

Cuba, East Africa, Central America and Madagascar have been made and these studies will be published at an early date.

The first volume of the catalogue of the Homoptera of the world is about ready for the press, and good progress is being made on the other volumes.

Project No. 3. The Corn Root Worm, Z. P. METCALF, Leader.

Careful studies have been made of the life history of this pest. These studies show that egg laying begins by mid March and continues to mid September. Hibernating females mate during the fall and commence to lay eggs as soon as the weather warms up in the spring. Records were kept on 192 females that laid eggs. These females laid a total of 15,414 eggs, or an average of 80 eggs per female. One female, however, laid a total of 284 eggs. Most of the eggs are laid during the month of April. The eggs hatch in 7 to 8 days on the average. The larval stage varies from 20 to 50 days, depending on temperature, moisture, food supply, and perhaps other factors. The pupal stage requires 8 to 9 days.

The rotation experiments at the Coastal Plains Test Farm have shown uniformly less damage on the rotated plats. The percentage of damage this past year was so small that it is not safe to draw any conclusions. The small percentage of injury was due, undoubtedly, to the abnormally dry spring months.

Project No. 4. Corn Ear Worm, B. B. FULTON, Leader.

Work on this project centered mainly on the pupation period in the soil. Starting with the first worms found in corn ears in July, a total of over two thousand worms were reared to maturity and placed in cages set in the ground. Each cage received worms maturing over a period of several days. A record was kept of the moths emerging in the cages.

Moths emerged within a month from nearly 70 per cent of the larvae placed in cages up to the middle of August. The percentage of moths emerging the same season from larvae pupating during the last half of August dropped off rapidly to 13 per cent in the last five days. There was an increase to 25 per cent for larvae pupating in the first half of September, followed by a further decrease to an average of less than 6 per cent of moths emerging from pupae formed in the last half of September. None were obtained the same year from October pupae.

During the summer of 1930 the infestation of ear worms was so severe that almost no ears escaped in the experimental plats. Weekly counts of eggs on fresh corn silks give an indication of the relative abundance throughout the season. The first counts on July 2 showed 45 per cent of the ears with eggs on the silk with an average of .9 egg per ear. This increased the next week to 73 per cent infestation and then dropped down to 27 per cent on July 19. From then on, there was a rapid increase in infestation to 100 per cent of the ears on August 8. The peak in the number of eggs deposited was reached August 19 with an average of over 18 eggs per mass of silks. There was then a gradual decrease in eggs deposited on fresh silks until the last count on September 24, when 53 per cent of the ears showed eggs with an average of .8 per ear.

Project No. 6. Wintering of Bees, F. B. Meacham, Leader.

This project has been under way for the past six years and as the results vary so much from year to year, it seems advisable to continue this work.

During the past year, a report was given on this subject before the North Carolina Academy of Science. Data for the last two seasons have been assembled and the results compare favorably was previous years. During 1928-29, fifteen colonies were used in the experiment and, contrary to previous results, the unprotected colonies made a very good showing. The next season's results are in favor of paper packing, but this can be accounted for by the fact that only a good representative colony was used for the record. Ten colonies during 1929-30 were used for records. The results for this season seem to favor the case packing method.

The conclusion from these experiments is that there is an advantage in giving the apiary added protection during the winter and that it would pay the small beekeeper to give this protection where many colonies are below the standard for successful wintering without protection. Young year-old queens give better results in the spring than older ones.

Project No. 7. A Survey of the Honey Producing Plants of the State, F. B. Meacham, Leader.

This is a continued project and a large amount of data has been assembled. Reports are coming in from different parts of the State. Several reports collected by a former worker have been turned over to the present leader and they were a valuable addition to our records. To date, thirteen reports from scattered areas in the Coastal Plain section of the State have been received. Seventeen from the Piedmont section and eighteen from the Mountain section. These include information about thirty-five different honey plants as to their blooming dates and honey production. Some of the leading honey plants of eastern North Carolina are tupelo gum, gallberry, huckleberry, and black gum. The most important from the Piedmont region are tulip poplar, alsike clover, sweet clover, vetch, and persimmon. For the Mountain section, the leading plants are sourwood, clovers, basswood, and tulip poplar. Numerous other plants in all sections show a great variation in the amount of surplus nectar produced.

The blooming dates of some of the plants from eastern sections have been tabulated and the following are representative examples: black gum, from May 3 to May 22; gallberry, May 10 to June 10; blackberries, April 30 to May 30. From such information, we are able to manipulate our bees so as to secure the maximum crop of honey from the plants when they bloom.

Project No. 8. The Bees of North Carolina, T. B. Mitchell, Leader.

Some additional material was collected during the past year and, therefore, some additional data concerning the occurrence and flower-visiting habits of native bees was obtained. Collections were made chiefly in the vicinity of Raleigh, Wilmington, and Marion, representing three quite distinct types of habitat.

Project No. 20. The Taxonomy and Biology of the Leaf-cutter Bees, T. B. Mitchell, Leader.

The revision of this genus of bees (*Megachile*) as it occurs in North America is considerably nearer completion than at this time last year, and it is hoped

that the manuscript will be finished by the end of the present fiscal year (1930-31). A paper describing 107 species new to science from South America was completed, and was published by the American Entomological Society, (Transactions Volume 56). The study of this South American material was of much value in determining the range of subgeneric groups represented in North America, and it is hoped that a more complete survey of the South and Central American species may be accomplished after the knowledge of the North American species has been brought up to date.

Project No. 24. Harlequin Bug, B. B. FULTON, Leader.

The results of two summers' work on the effect of contact insecticides on the harlequin bug have been published as Paper No. 38 of the Journal Series. Tests of various known contact insecticides on the harlequin bug, *Murgantia histrionica*, brought out the fact that certain soap solutions are very effective, but only under conditions of low evaporation. Further experiments under known rates of evaporation show that the efficiency of soap solution is indirectly proportional to the rate of evaporation. The addition of hygroscopic substances did not materially increase the effectiveness. Tests with several kinds of soap on two other species of insects show that the relationship is probably a general one. Plantings have been made for further experiments with trap crops.

Project No. 26. The Genetics of Habrobracon, C. H. BOSTIAN, Leader.

In the parasitic wasp, *Habrobracon juglandis*, virgin females produce only males, while mated females produce both males and females. The conclusion has been drawn that all males come from unfertilized eggs. This conclusion was proved to be untenable. From the cross of recessive orange-eyed females by related black-eyed males, there appeared orange males and black, heterozygous females, as expected, and in addition, a few black males which must have received their eye color from the male parent.

Such biparental males have been produced in the last few years in a great variety of crosses of females recessive for traits by males having the dominant traits. Several important facts have been learned concerning the production of these biparental males:

1. Biparental males are produced only in crosses involving related stocks.
2. The proportion of biparental males to biparental males plus females ranges from 0 to not more than 10 or 15 per cent.
3. Over 80 per cent of all biparental males tested have proved sterile.
4. The offspring produced by the few fertile biparental males have been very abnormal and completely sterile.
5. There is no evidence of intersexuality among the biparental males. They are normal males in both appearance and instincts.
6. Higher temperatures (about 86° F.) produce a larger percentage of biparental males than lower temperatures (about 60° F.).
7. Biparental males are probably diploid.
8. Attempts to increase the proportion of biparental males by selection have been successful, indicating that the tendency to produce biparental males is hereditary to some extent.

This investigation aims to throw some light on the question of sex-determination in *Habrobracon*. These experiments are primarily concerned with

attempts to explain why biparental males are produced only in related stocks, and to learn more about the inheritance of the tendency for producing the biparental males.

In addition, some time will be devoted to testing mutations which occur in *Habroracon*, and in determining the linkage relationships of the genes for such mutations.

CONTRIBUTIONS TO SCIENTIFIC JOURNALS

The following contributions to scientific journals by members of the staff should be noted.

The Relation of Evaporation to Killing Efficiency of Soap Solutions on the Harlequin Bug and Other Insects, by B. B. Fulton, *Journal of Economic Entomology* 23: 625-630.

A New Species of Nemobius from North Carolina, by B. B. Fulton. *Entomological News* 41: 38-42.

A description of *Nemobius sparsalus* n. sp. from a salt marsh at Carolina Beach, North Carolina.

Contribution to the Knowledge of Neotropical Megachile with Descriptions of New Species, by T. B. Mitchell. *Translations of the American Entomological Society* 56: 155-305; plates 10-14.

Nomenclature, by Z. P. Metcalf, *Science* 72: 318-319.

On the whole, the research work of the Department of Zoölogy and Entomology has progressed in a satisfactory manner, considering funds and personnel available.

Z. P. Metcalf,
Entomologist.

FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture, and sales from the Station farms, with a record of their disbursement:

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In account with the UNITED STATES APPROPRIATION, 1929-1930.

Dr.

	Hatch Fund	*Adams Fund*	*Purnell Fund*
To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1930, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund), and February 24, 1925 (Purell Fund)	$15,000.00	$15,000.00	$60,000.00

Cr.

Salaries	$12,913.00	$12,300.00	$39,384.70
Labor	122.12	450.10	5,444.22
Stationery and office supplies	16.58	138.37	287.62
Scientific supplies, consumable	41.96	690.51	1,068.87
Feeding stuffs	.....	146.43	4,185.40
Sundry supplies	155.28	205.06	516.34
Fertilizers	26.40	9.15	215.06
Communication service	5.55	2.62	87.94
Travel expenses	1,617.56	515.24	4,250.88
Transportation of things	91.87	44.77	236.40
Publications	.....	.....	1,924.64
Heat, light, water and power	.....	79.77	119.51
Furniture, furnishings, fixtures	.....	27.29	562.64
Library	.....	.....	58.81
Scientific equipment	.....	188.42	943.43
Livestock	.....	.....	45.89
Tools, machinery, and appliances	9.68	152.27	626.56
Buildings and land	.....	50.00	39.00
Contingent expenses	.....	.....	2.09
Total	$15,000.00	$15,000.00	$60,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In account with FARM AND MISCELLANEOUS RECEIPTS.

Dr.

State Department of Agriculture	$60,000.00
Sales	15,537.14
Special endowments, industrial fellowships and similar grants	7,163.84
Miscellaneous	537.06
Total	$83,238.04

Cr.

Salaries	$40,733.50
Labor	8,568.48
Stationery and office supplies	830.37
Scientific supplies, consumable	509.66
Feeding stuffs	6,163.64
Sundry supplies	1,931.81
Fertilizers	1,641.28
Communication service	943.01
Travel expenses	9,291.12
Transportation of things	594.60
Publications	547.50
Heat, light, water and power	862.13
Furniture, furnishings and fixtures	415.78
Library	682.79
Scientific equipment	91.07
Livestock	2,545.00
Tools, machinery and appliances	1,227.15
Buildings and land	1,191.35
Contingent expenses	463.14
Unexpended balance	4,004.66
Total	$83,238.04

We, the undersigned, duly appointed auditors of the expenditures from Federal appropriations reported herein, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1930; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was *nothing* on the Hatch Fund, *nothing* on the Adams Fund, and *nothing* on the Purnell Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the Act of Congress of March 2, 1887, $15,000.00 under the act of Congress March 16, 1906, and $60,000.00 under the act of Congress of February 24, 1925, and the corresponding disbursements $15,000.00, $15,000.00, and $60,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of *nothing*, *nothing*, and *nothing*, respectively.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

(Signed)

R. Y. WINTERS,
Director of the Experiment Station.

A. F. BOWEN,
Financial Officer of the Institution.

A. S. BROWER,
Comptroller.

(Seal)
Attest:

A. F. BOWEN,
Custodian of the Seal.